**HYDROGRAPHIC & GEOPHYSICAL SURVEY REPORT**

**HKA CABLE ROUTE SURVEY**

**MANCHESTER, CALIFORNIA**

Contractor Document No:
MANCHESTER_HKA_CABLE_ROUTE_HYDROGRAPHIC_GEOPHYSICAL_REPORT.A5

| | | | | | | |
|---|---|---|---|---|---|---|
| 11/15/2018 | A5 | Client Review | NG | MM | MM | |
| 10/30/2018 | A4 | Client Review | NG | MM | MM | |
| 10/25/2018 | A3 | Client Review | NG | MM | MM | |
| 10/19/2018 | A2 | Client Review | NG | MM | MM | |
| 09/20/2018 | A1 | Internal Review | NG | MM | MM | |
| Date | Revision | Description of Revision | Prepared | Checked | Approved | Client |

**www.etracinc.com**

email: Nick George **nick@etracinc.com** & Mike Mueller **mike@etracinc.com**

# Table of Contents

# Figures

# Tables



**Acronyms and Abbreviations**

| | |
|---|---|
| ° | degree(s) |
| 3D | three dimensional |
| ACSM | American Congress on Surveying and Mapping |
| ASN | Alcatel-Lucent Submarine Networks |
| BMH | Beach Manhole |
| cm | centimeter |
| COR | Contracting Officer Representative |
| CRS | Cable Route Survey |
| CSF | Composite Source File |
| DB | QINSy database |
| DCC | Distance Cross Course |
| eTrac | eTrac Inc. |
| Fugro | Fugro Singapore Marine Pte Ltd |
| GLONASS | global navigation satellite system |
| GNSS | global navigation satellite system |
| GPS | global positioning system |
| HKA | Hongkong – America Consortium |
| Hz | hertz |

| | |
|---|---|
| ID | identification |
| IHO | International Hydrographic Organization |
| JSF | EdgeTech native file format |
| KP | Kilometer Point |
| LAT | Lowest Astronomical Tide |
| m | meter |
| m/s | meters per second |
| MAG | Magnetometer |
| MAR | Marine Advanced Research Inc |
| MBES | multibeam echosounder system |
| MLLW | Mean Lower Low Water |
| NAD83 | North American Datum 1983 |
| NGS | National Geodetic Survey |
| NOAA | National Oceanic and Atmospheric Administration |
| OPUS | Online Positioning User Service |
| pdf | Adobe Portable Document Format |
| POSMV | position and orientation system for marine vessels |
| PPK | Post Processed Kinematic |
| QPS | Quality Positioning Systems |
| RTK | real time kinematic |
| RPL | Route Point List |
| SBET | smoothed best estimate of trajectory |
| SBP | Sub-bottom Profiler |
| SSS | Sidescan Sonar |

| | |
|---|---|
| THSOA | The Hydrographic Society of America |
| USM | universal sonar mount |
| WGS84 | World Geodetic System 1984 |
| XTF | Extended Triton Format |

# EXECUTIVE SUMMARY

Between June 17th 2018 to June 21st 2018, July 5th, July 6th and August 26th to 30th 2018 eTrac Inc. completed a topographic, geophysical and bathymetric survey of the Manchester landing site (Beach landing and nearshore) area located nearshore off of Manchester, California in support of the HKA Cable Route Survey. The survey area consists of a 500 meter cable corridor centered on the planned cable route which extends from 2 meters water depth on the shoreward to the 3 nautical mile demarcation line. Also included in the survey area is an additional 500 meter wide area centered on the planned cable route 500 meters past the 3 nautical mile limit to overlap the pacific crossing survey being conducted to the 3nm state limit. This report covers the geophysical and bathymetric survey.

# 1. INTRODUCTION

## 1.1 Contract and Scope

This report is prepared for Marine Advanced Research Inc. (MAR) a subcontractor to Fugro Singapore Marine PTE LTD (Fugro) for Alcatel-Lucent Submarine Networks (ASN) by eTrac Inc. (eTrac) under the Alcatel HKA Cable Route Survey Inshore California Survey Job Number: P03437, to perform an inshore marine geophysical and bathymetric survey in Hermosa, California. The principal objective of the inshore Marine Cable Route Survey is to confirm or amend the preliminary post Cable Route Study (CRS) route as proposed by ASN, to ascertain a feasible and safe route for cable system design, deployment, survivability, and subsequent maintenance. Another objective of this survey is to assist ASN with decisions regarding cable armoring by identifying all route obstacles and cable hazards and providing information to support cable route and installation engineering.

## 1.2 Survey Area

The survey area is defined as a polygon using the Route Point List (RPL) according to file "HKA_SEG_5_MANCHESTER TO BU4_RPL_PSR01_18-JULY-2018.dwg" dated July 18th 2018. This is an updated RPL from the original file "ACAD-S5_RPL_5k" as received June 25th 2018, for the Manchester Beach Manhole (BMH) landing site. This site is located in Manchester , CA on Manchester Beach. The area includes a nearshore area bounded by a buffer of 250 meters to either side of the RPL and 500 meters offshore of the 3nm state waters boundary.

Figure 1 below shows the project area location.

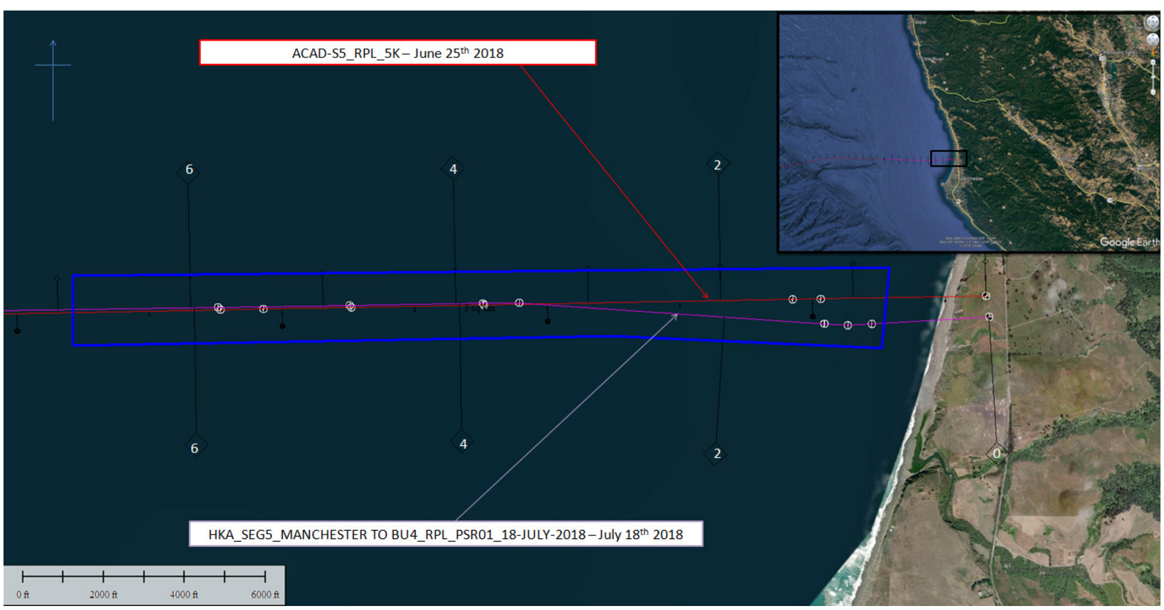



Figure 1: Survey Area Location

### 1.2.1 Nearshore Survey Area

The nearshore survey consists of a polygon bounded by a buffer of 250 meters to either side of the cable alignment and 500 meters offshore of the 3nm state waters boundary (see Figure 2). The nearshore extent of the survey area for all bathymetric and geophysical operations is defined as the 3m contour in reference to LAT. All operations required in the nearshore survey area will support the measurement, study, and investigation of the bathymetry, seabed features, shallow geology, and potential hazards along the cable route.

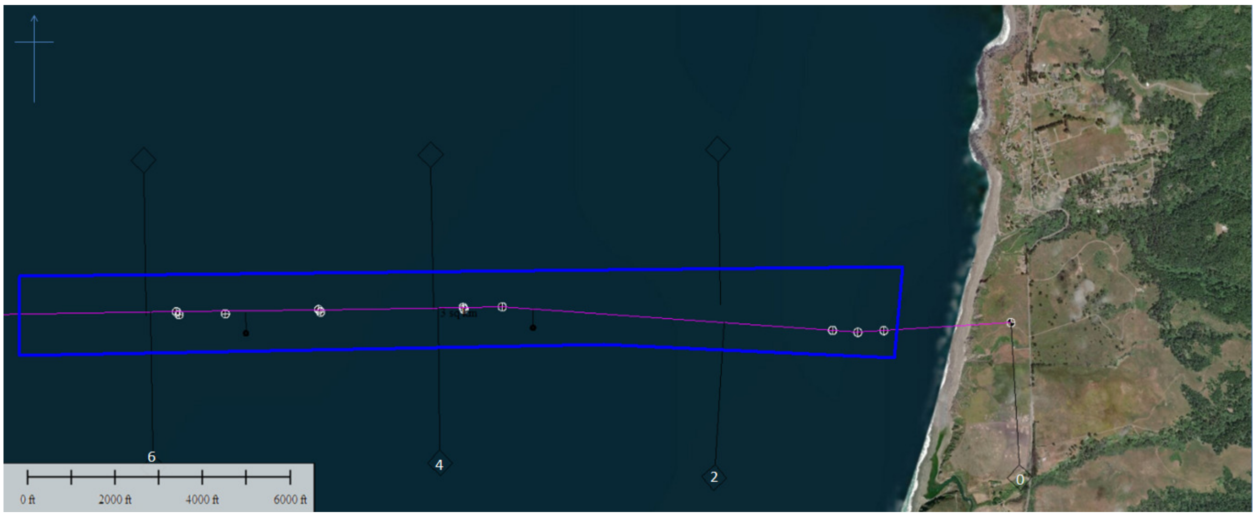



Figure 2: Nearshore Survey Area

The survey area required 100% coverage with 20% overlap for the multibeam echosounder (MBES) and sidescan sonar (SSS) data acquisition to map seabed morphology. Sub-bottom profiler (SBP) data were required to be collected along transects spaced at 80 meter intervals from the cable alignment to determine thickness and nature of the sediments depending on depth. Magnetometer (MAG) data were required to be collected at the as charted offshore cable crossing of the alignment. Sediment grab samples were required to be collected at 500m intervals along the proposed cable alignment.

## 1.3 Company Overview

eTrac Inc. was established in 2003 as a hydrographic and geophysical surveys, vessel positioning and instrumentation firm. eTrac has several offices along the US West Coast including San Francisco, Seattle and Anchorage. The firm has earned a strong reputation among many sectors of the hydrographic industry, including government agencies and private industry. Its equipment fleet has also grown to include 8 aluminum geophysical survey vessels as well as several ultraportable, shallow water survey craft. eTrac’s role has grown over the years to include a strong group of full-time staff as well as several localized vessels to support the work required by the USACE, marine construction, engineering firms and petroleum industry contractors on the West Coast. eTrac is committed to continual re-investment in industry leading equipment and knowledgeable staff to complete multibeam, singlebeam, sidescan, mobile LiDAR, sub-bottom, and water-level surveys required by our clients. Staffed with professionally licensed land surveyors and ACSM/THSOA (American Congress on Surveying and Mapping/The Hydrographic Society of America) certified hydrographers, eTrac’s projects are performed at the highest level of quality and detail that the industry demands.

# 2 OBJECTIVES

eTrac completed a bathymetric and geophysical survey in support of the HKA Cable Route Inshore Survey at BMH Manchester . The requirement of the project is to provide seafloor bathymetry, sidescan sonar imagery, sub-bottom stratigraphy, and identification of surface and subsurface features.

The objectives of this survey are as follows:

- Determine the stratigraphic and geologic characterization of sediments, soil, and bedrock underlying the nearshore survey area
- Identify and analyze objects and debris larger than 1m x 1m x 1 m using SSS within the nearshore survey area
- Identify and locate cable or other utilities routes across the RPL

# 3 SURVEY CALENDAR AND PERSONEL

The survey began on June 16th with the mobilization of the multibeam and positioning systems. The final day was August 30th 2018 when all systems were demobilized from the vessel. The survey activities calendar is below in Table 1.

Table 1: Survey Calendar

| Date | Survey Activities |
|---|---|
| June 16 , 2018 | RV 505 arrives at Noyo, CA and R/V 505 Mobilization |
| June 17 , 2018 | Complete Mobilization of RV 505. Launch RV 505 equipment testing. RV 505 Equipment Calibrations, Bar Check, Patch Test. |
| June 18, 2018 | RV 505 Acquire MBES & SBP |
| June 19, 2018 | Crew transit out toward site - turn back due to weather |
| June 20, 2018 | RV 505 Acquire MBES & SBP |
| June 21, 2018 | Crew transit out toward site - turn back due to weather |
| June 22, 2018 | Crew transit out toward site - turn back due to weather |
| June 23, 2018 | Crew transit out toward site - turn back due to weather |
| June 24, 2018 | Crew transit out toward site - turn back due to weather |
| June 25, 2018 | Crew transit out toward site - turn back due to weather |
| June 26, 2018 | Begin R/V 505 Demobilization |
| July 2, 2018 | WAM-V Mobilization |
| July 4, 2018 | WAM-V transit to Point Arena and support vessel to Noyo |
| July 5, 2018 | WAM-V Acquire MBES |
| July 6, 2018 | WAM-V Acquire MBES |
| July 7, 2018 | WAM-V Demobilization |
| August 23, 2018 | M/V Jab Mobilization |
| August 26, 2018 | Complete Mobilization of M/V Jab. Launch MV Jab equipment testing. MV Jab Equipment Calibrations, Bar Check, Patch Test. |
| August 27, 2018 | M/V Jab Acquire MBES, SSS, SBP, & Mag |
| August 28, 2018 | M/V Jab Acquire MBES, SSS, SBP, & Mag |
| August 29, 2018 | M/V Jab Acquire MBES, SSS, SBP, & Mag |
| August 30, 2018 | M/V Jab Acquire Bottom Samples |
| August 31, 2018 | M/V Jab Demobilization |

Three consolidated survey efforts took place. Firstly between June 16th and June 26th R/V 505 was mobilized and used for survey. During this time production days were limited by adverse weather in the area. In addition within the survey area were crab pots and other commercial fishing infrastructure. This made towing side scan impossible. R/V 505 was ordered to stand down on June 26th 2018. The WAM-V was mobilized on July 2nd. The WAM-V acquired multibeam echosounder data in the shallower water where, due to conditions and risk, R/V 505 was not able to enter. In August, when weather conditions were more amenable to survey and the fishing season had ended, M/V Jab was mobilized to complete acquisition.  Between the June R/V 505 survey efforts and the August M/V Jab survey, the RPL was revised based on rock outcroppings identified in the June dataset as well as the Manchester BMH location having to be revised and moved south by 200m.

Personnel assigned to the survey are listed below.

**eTrac**
Michael Mueller - Project Manager
David Neff - Project Site Manager and Marine Mammal Observer
Nicholas George - Processing Manager
Isadora Kratchman - Report Manager and Hydrographic Processor
Ben Churchwell - Lead Hydrographic Tech and Hydrographic Processor
Kayla Johnson - Hydrographic Tech, Hydrographic processor, and Marine Mammal Observer
Chris Ham - Lead Hydrographic Tech, Marine Mammal Observer, and Hydrographic processor
Greg Crenshaw - Hydrographic Tech and Hydrographic Processor
Gerhard Skerbinek - Vessel Captain, Vessel Transport and Marine Mammal Observer
Anthony Salas - Vessel Support and Vessel Transport Support

**Marine Advanced Research**
Mark Gundersen – Project Manager
James Coleman - Lead Hydrographic Tech and Hydrographic Processor
Joshua Mehlman – WAM-V ASV Operator
Kurt di Sessa – Technician
Brayton Pointner - Vessel Captain and owner of M/V Jab

**Fugro**
Lew Lian Fui – Project Manager, Contracting Officer Representative (COR) for eTrac, sediment sample classification
Christian Iserentant – Inshore Project Manager
Brent Humphries - Hydrographic Tech

**ASN**
Mark Jonkergouw – Project Manager
Soeren Christensen – Project Manager Marine
Rachel van Oppen – Project Manager Marine

# 4 METHODOLOGY

## 4.1 Survey Vessels

As detailed in the mobilization report R/V 505 (Figure 3) ,WAV-V 20 (Figure 4) and M/V Jab (Figure 5) were used for hydrographic survey operations for this project. R/V 505 and M/V Jab were also used for all geophysical survey operations for this project.

On both R/V 505 and M/V Jab positioning and motion detection system were installed on the vessel with a long antenna base allowing maximum heading accuracy. Multibeam systems were mounted with a Universal Sonar Mount (USM). The side scan sonar and sub-bottom profiler were both mobilized on R/V 505 and M/V Jab and on both vessels the systems were towed using a sheave with a block and winch of the stern.  The magnetometer was towed in tandem with the side scan sonar on both vessels.

On the WAM-V 20 a positioning and motion detection system was installed on the vessel with a long antenna base allowing maximum heading accuracy. A multibeam system was mounted with a custom sonar mount.

**Figure 3: R/V 505**

**Figure 4: WAM-V 20**

**Figure 5 M/V Jab**

## 4.2 Equipment

Precise positioning and motion systems, high resolution multibeam sonars, a sediment grab sampler, a sidescan sonar system, a CHIRP sub-bottom sonar system, and a magnetometer were installed for this project and are described below.

### 4.2.1 Positioning System

As detailed in the mobilization report, R/V 505 and M/V Jab were positioned and motion accounted for using an Applanix POS Oceanmaster V5 and the WAM-V 20 was positioned and motion accounted for using an Applanix POS Wavemaster V5.

### 4.2.2 Positioning System

For horizontal positioning R/V 505 and M/V Jab were equipped to receive DGPS coast guard corrections from nearby coast guard beacons:
Primary: Point Loma – ID 881 – Freq: 302

DGPS corrections on the R/V 505 and M/V Jab were provided by a Hemisphere MBX-4 positioning system receiving corrections from the U.S. Coast Guard beacon located at Cape Mendocino.

The Mobilization Report detailing the QC methods for the POS MV Positioning system can be found in Appendix A – Mobilization Report.

### 4.2.3 Cable Counter

During SSS, SBP, and MAG operations, Towfish cable payout was measured with the Hydrographic Survey Projects, Inc. SCC Smart Sensor. The system is comprised of a sheave block fitted with the SCC sensor and 2 magnets. The sheave block is coupled with the SCC display interface. Cable payout messages were sent via DB9 serial cable to SonarWiz acquisition software.
Further details of this system can be found in the Mobilization Report.

### 4.2.4 Multibeam Sonar

An R2 Sonic 2024 multibeam system ( Figure 6) was used for all bathymetry data acquisition on R/V 505. The system used is capable of running at 400 kHz to get the highest resolution dataset.

Figure 6: R2 Sonic 2024 Multibeam Echosounder System

An R2 Sonic 2022 multibeam system (Figure 7) was used for all bathymetry data acquisition on M/V Jab. The system used is capable of running at 400 kHz to get the highest resolution dataset.

Figure 7 R2 Sonic 2022 Multibeam Echosounder System

An R2 Sonic 2020 multibeam system (Figure 8) was used for all bathymetry data acquisition on the WAM-V. The system used is capable of running at 400 kHz to get the highest resolution dataset.

Figure 8: R2 Sonic 2020 Multibeam Echosounder System

The specifications of each of these systems is detailed below in Table 2.

Table 2 R2 Sonic Multibeam Echosounder Specifications

| | Sonic 2020 | Sonic 2022 | Sonic 2024 | Sonic 2026 |
|---|---|---|---|---|
| Applications | Entry level hydrography<br>Very small vessels<br>Small ASV and AUV | Construction<br>Dredging<br>Autonomous Surface Vehicle (ASV)<br>Offshore O&G (pipeline) | Autonomous Surface Vehicle (ASV)<br>Construction<br>Dredging<br>Offshore O&G (pipeline)<br>Offshore WindFarm (cable, towers) | Advanced hydrography<br>Research<br>Seafloor characterization<br>Autonomous Underwater Vehicle (AUV)<br>Remote Operated underwater Vehicle (ROV) |
| Selectable Frequencies | 200kHz - 400kHz. Optional 700kHz | 170 - 450kHz. Optional 700kHz | | 170 - 450kHz. Optional 90kHz and 100kHz |
| Minimum frequency increase | 1Hz | | | |
| Beamwidth, across track and along track | 1° x 1° at 700kHz (optional)<br>2° x 2° at 400kHz<br>4° x 4° at 200kHz | 0.6° x 0.6° at 700kHz (optional)<br>0.9° x 0.9° at 450kHz<br>2° x 2° at 200kHz | 0.3° x 0.6° at 700kHz (optional)<br>0.45° x 0.9° at 450kHz<br>1° x 2° at 200kHz | 0.45° x 0.45° at 450kHz<br>1° x 1° at 200kHz<br>2° x 2° at 90kHz & 100kHz (optional) |
| Number of soundings | Up to 1024 soundings per ping | | | |
| Max speed (vessel) | 11.1 knots for full coverage (*) | | | |
| Near-field focusing* | Yes | | | |
| Roll stabilized beams | Yes | | | |
| Pitch stabilized beams | Yes | No | | Yes |
| ROBO™ Automated Operation | Yes<br>Auto Power, pulse width, rangeTrac™, GateTrac™, SlopeTrac™ | | | |
| Saturation monitor | Yes | | | |
| Selectable Swath Sector *(also referred as Max Coverage)* | 10° to 130°<br>User selectable in real-time | 10° to 160°<br>User selectable in real-time | | |
| Sounding Patterns | Equiangular<br>Equidistant<br>single / double / quad modes<br>Ultra High Density (UHD) | | | |
| Sounding Depth | up to 200m+ | up to 400m+ | | up to 800m+ |
| Pulse Length | 15µs - 1ms | | | 15µs - 2ms |
| Pulse Type | Shaped CW | | | |
| Ping rate | up to 60Hz | | | |
| Bandwidth | up to 60kHz | | | |
| Immersion Depth | 100m<br>Optional 4000m | | 100m<br>Optional 4000m & 6000m | 100m<br>Optional 4000m |
| | *Note: FLS projectors are rated 3000m instead of 4000m* | | | |
| Bottom Detect Resolution | 3mm | | | |
| Operating Temperature | -10°C to 40°C | -10°C to 50°C | | |
| Storage Temperature | -30°C to 55°C | | | |
| **Electrical Interface** | | | | |
| Mains | 90-260VAC, 45-65Hz | | | |
| Power consumption | 20W avg | 35W avg | 50W avg | 100W avg |
| Uplink/downlink | 10/100/1000Base-T Ethernet | | | |
| Sync in, Sync out | TTL | | | |
| Deck cable length | 15m, optional 25m and 50m | | | |

The R2Sonic 2024, 2022 and 2020 system are all controlled using the R2 sonic controller (seen below in Figure 8). The setting changes that can be made include the range, gain, power, pulse width, absorption and saturation. These are monitored and adjusted accordingly. Swath width is also adjusted using the R2 sonic controller.

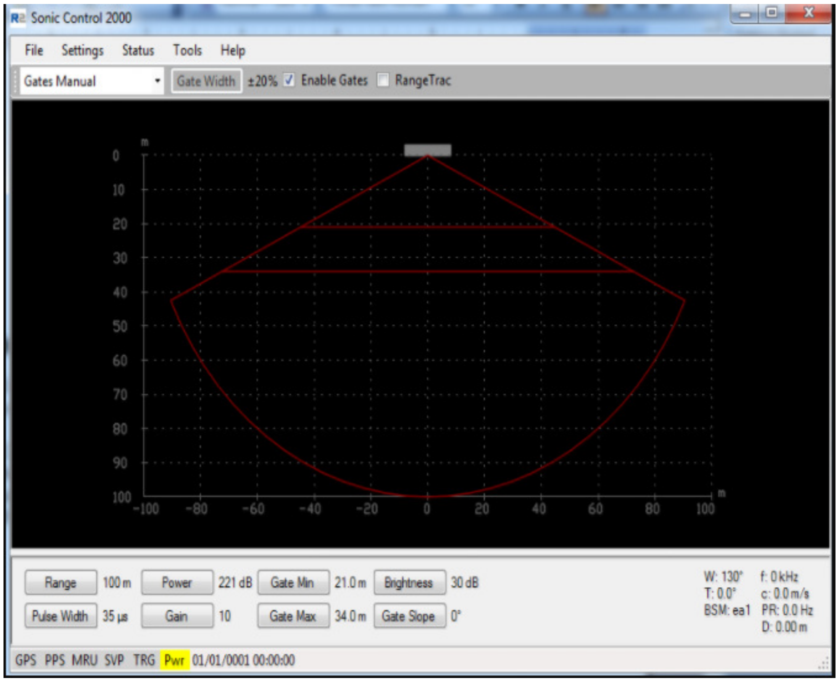



Figure 9: R2 Sonic Control 2000

Data was logged in QINSy as .DB files containing bathymetry data on R/V 505 and Wam-V. On M/V Jab data was logged in Hypack.

As described in the Mobilization Report, the top center of the IMU was chosen as the reference point and measurements were taken in the x, y, and z direction between the RP and the R2 Sonic Acoustic Center and used to position the system. These offsets were applied in the vessel Database in QINSy for R/V 505 and WAM-V (Hypack on M/V Jab) and position was calculated and recorded in real-time. The R2Sonic position is displayed in the QINSy or Hypack shell as a node.

Further details of the calibration and QC methods for multibeam system can be found in the Mobilization Report.

### 4.2.5 Singlebeam Sonar

R/V 505 was equipped with an Odom EchoTrac CV100 singlebeam echosounder in single channel configuration with a SMSW200-4a transducer . Single beam data was not acquired due to the fact that QC against the two other vessels and multibeam systems was deemed sufficient.

### 4.2.6 Sound Velocity

As described in the Mobilization Report, sound velocity profiles were obtained on the R/V 505, M/V Jab and WAM-V at pre-planned intervals during all surveys to adjust the computation of MBES, and SBES refraction and ranging of data due to speed of sound variation in the water column.


**AML Base X2 Sound Velocity Profiler**

•Depth Range: up to 500 meters
•Sound Velocity Range: 1375 to 1625 m/s
•Sound Velocity Precision (+/-): 0.006 m/s
•Sound Velocity Accuracy (+/-): 0.025 m/s
•Sound Velocity Resolution: 0.001 m/s
•Pressure Range: Up to 6000 dBar

Figure 10: AML Base X2 Sound Velocity Profiler

An AML Base X 2 Profiler (See Figure 10 for image and details) was used as the sound speed profiler due to its high accuracy time of flight sound speed sensor, which is capable of measuring sound speed in depths up to 500 meters. The AML Base X 2 is capable of transferring data via WiFi. AML SeaCast software was run on the acquisition computer to facilitate the data transfer and profile formatting.


**AML Micro X sound Velocity Probe**

•Depth Range: up to 500 meters
•Sound Velocity Range: 1375 to 1625 m/s
•Sound Velocity Precision (+/-): 0.006 m/s
•Sound Velocity Accuracy (+/-): 0.025 m/s
•Sound Velocity Resolution: 0.001 m/s

Figure 11: AML Micro X Sound Velocity Probe

During MBES survey on the R/V 505, M/V Jab and the WAM-V an AML Micro X (see Figure 11 for image and details) was utilized by the R2Sonic 2024, 2022 and 2020 for the surface sound speed measurement. The AML Micro X is a time of flight SV sensor and is powered through the R2Sonic topside unit via RS232 serial cable connection. Sound speed measurements (measured in meters per second) are output through the same serial connection at 1Hz.

Details of the sound velocity profiler systems can be found in the Mobilization Report.

### 4.2.7 Grab Sampler

A WILDCO Ponar grab sediment sampler system was used for all sediment collection( Figure 12). The Ponar grab is a self closing stainless steel grab sampler and has a sample volume of 500 Cubic Inches and measures 9'Wx9'L. Further details of the grab sampler can be found in the Mobilization Report.

Figure 12: WILDCO Ponar Grab Sampler

### 4.2.8 Sidescan Sonar

As discussed in the mobilization report, R/V 505 and M/V Jab were equipped with an Edgetech 4200 sidescan sonar system with a 701-DL topside interface for surface object detection. The dual frequency sonar operated at frequencies 300kHz and 600 kHz concurrently. The sidescan sonar was towed using a 300m length of armored tow cable. The tow cable was wound onto a custom electric winch mounted to the cabin top of the RV 505 vessel and on M/V Jab the cable was wound on a hydraulic winch. On R/V 505 electronic control of the winch direction was initiated with a remote control unit handled by the

hydrographic surveyor on the deck of the vessel. On M/V Jab the hydraulic winch was controlled from within the cabin as well with controls on the back deck.
Layback of the tow fish was computed in SonarWiz software (caternary and cable incl.) using both physical measurements from the cable (alternating 2 and 3 meter markings) as well as an electronic hall effect sensor-based cable counter on a dedicated sheave. The sheave was suspended from a davit towed from a point on the centerline of the stern of the vessel. Electronic cable payout information was input in real-time via serial data to the acquisition computer and applied in the SonarWiz software.


Figure 13: EdgeTech 4200 Sidescan Sonar

### 4.2.9 Sub-bottom Profiler

As discussed in the Mobilization report, R/V 505 and M/V Jab were equipped with an Edgetech Chirp 216S sub-bottom profiler with a 3200X topside to understand the shallow subsurface stratification (up to 30 feet below seabed) and for subsurface object detection.
The Edgetech Chirp 216S (Figure 14) has a frequency modulated pulse and was set to 2-15 kHz with a 20 ms pulse width and Edgetech Pulse ID 25129. The sub-bottom profiler was towed using a fixed layback in the Discover software from the same tow point used for the sidescan sonar operations. Line navigation during acquisition was handled using QINSy software and the Applanix POSMV. The sub-bottom profiler data was collected using a depth range adjusted by the on-line surveyor. The range varied according to the depth of penetration desired and depth of the seabed in the area being surveyed.

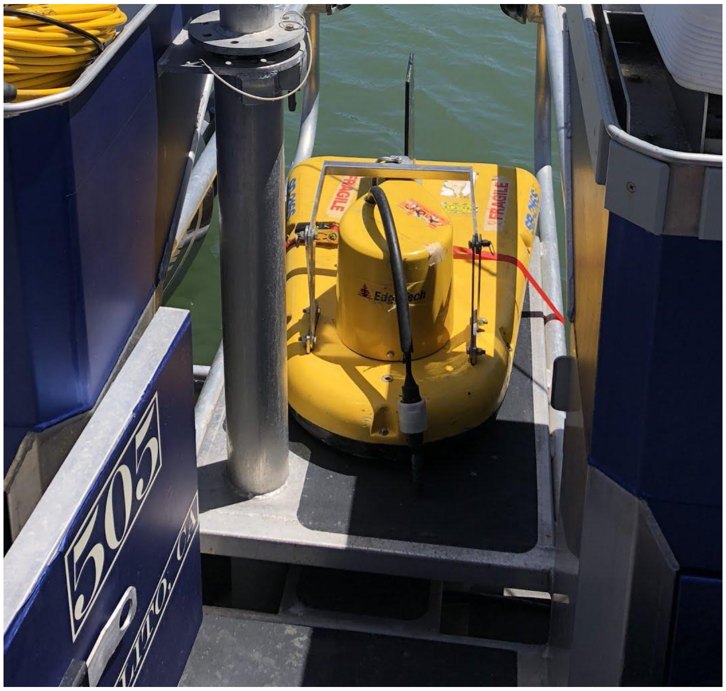


Figure 14: EdgeTech Chirp 2016S

### 4.2.10 Magnetometer System

As discussed in the mobilization report R/V 505 was mobilized with a Geometrics G-882 cesium marine magnetometer (Figure 15) to detect cable crossings. This system detects ferrous objects below and at the surface of the seabed.

Figure 15: Geometrics G-822 Cesium Magnetometer

The G-882 was towed in tandem (i.e. aft of) the 4200 sidescan sonar towfish. Layback of the magnetometer was computed as an offset of 9meters from the sidescan position computed in the SonarWiz software. SonarWiz was configured to accommodate the serial messages from the 4200 sonar which acts as a pass-through for the information from the 882 magnetometer. The magnetometer data was recorded to the SonarWiz JSF files and extracted in post-processing from SonarWiz as well. Line navigation during acquisition was handled using QINSy software and the Applanix POSMV.

## 4.3 Data Acquisition

### 4.3.1 Multibeam Bathymetry

All multibeam data was acquired as outlined. The combined POSMV and R2 Sonic multibeam systems were used to acquire all multibeam bathymetry data. The R2Sonic 2024, 2022 and 2020 were run at 400 kHz to allow hi-res data. As described in section 4.2.6 of this report, for all multibeam data the sound speed both at the sonar head and through the water column was accounted. An AML micro X and an AML Base X2 were used. During multibeam acquisition sound velocity profiles were acquired every 2 – 3 hours and applied in real-time on R/V 505 in QINSy, and in Hypack on M/V Jab and in post processing for the WAM-V 20 MBES data. As described in the Mobilization Report, the AML Base X2 sound velocity profile and the AML micro X sound velocity at the head were compared.
As described the Mobilization Report, multibeam data was collected to achieve 100% bottom coverage with 20% overlap for seabed morphology. This achieved coverage is further explained in section 4.4.1 of this report.

### 4.3.2 Singlebeam Bathymetry

Within the project area, overlapping multibeam data was acquired from three different systems on three different vessels. This was deemed sufficient quality control for the bathymetry data without having to acquire additional singlebeam data. It was agreed in the field with the ASN representative that no singlebeam data acquisition would be required.

### 4.3.3 Sediment Sampling

Sediment grab samples were completed as outlined. The sediment sampler was dropped at each site location and a fix marked of the estimated position the sample was taken. Each sample was retrieved and then placed in a plastic container, labeled and photographed. In field analysis was completed. Each sample was classified by color using a Munsell soil chart and grain size using the ASN soil classification.

### 4.3.4 Sidescan Sonar

All sidescan sonar data was acquired as outlined. The EdgeTech 4200 was used to acquire all sidescan sonar data. As previously described in the Mobilization Report, the dual frequency sonar operated at frequencies 300kHz and 600 kHz concurrently. The sidescan sonar was towed using a 300m length of armored tow cable. The tow cable was wound onto a custom electric winch mounted to the cabin top of the RV 505 vessel. Electronic control of the winch direction was initiated with a remote control unit handled by the hydrographic surveyor on the deck of the vessel. For the side scan sonar operations on M/V Jab the system was towed on the hydraulic winch from a stern tow point. The operator controlled the winch from the cabin.

Layback of the tow fish was computed in SonarWiz using both physical measurements from the cable (alternating 2 and 3 meter markings) as well as an electronic hall effect sensor-based cable counter on a dedicated sheave. On both R/V 505 and M/V Jab, the sheave was suspended from a davit towed from a point on the centerline of the stern of the vessel. Cable payout information was input in real-time via serial data to the acquisition computer and applied in the SonarWiz software.

### 4.3.5 Sub-bottom System

All sub-bottom sonar data was acquired as outlined. The EdgeTech Chirp 216S was used to acquire all sub-bottom data. As previously described as well as described in the Mobilization Report, the Edgetech Chirp 216S has a frequency modulated pulse and was set to 2-15 kHz with a 20 ms pulse width and Edgetech Pulse ID 25129. On the R/V 505, the sub-bottom profiler was towed using a fixed layback in the Discover software from the same tow point used for the sidescan sonar operations. Line navigation during acquisition was handled using QINSy software and the Applanix POSMV. Data acquisition on M/V Jab was concurrent with side scan and sub-bottom data towed at the same time. The sub-bottom was deployed at a fixed cable out and tied off on the starboard side, stern cleat. Hypack was used for line navigation during operations on M/V Jab. All sub-bottom profiler data was collected using a depth range adjusted by the on-line surveyor. The range varied according to the depth of penetration desired and depth of the seabed in the area being surveyed.

### 4.3.6 Magnetometer System

Magnetometer data was acquired along the same lines as the side scan sonar. The system was tandem towed with and behind the side scan fish. The Geometrics G-882 Cesium system was used to acquire all magnetometer data. As described in the Mobilization Report, the G-882 was towed in tandem (i.e. aft of) the 4200 Sidescan sonar towfish. Layback of the magnetometer was computed as an offset of 9meters from the sidescan position computed in the SonarWiz software. As described above in section B.2.2.1., the caternary and cable payout out values supplied to the software contributed to the computation of the layback value in real-time. Both physical measurements from the cable (alternating 2 and 3 meter markings) as well as an electronic hall effect sensor-based cable counter on a dedicated sheave were used to supply data to the software. SonarWiz was configured to accommodate the serial messages from the 4200 sonar which acts as a pass-through for the information from the 882 magnetometer. The mag data was recorded to the SonarWiz JSF files and extracted in post-processing from SonarWiz as well.

Line navigation during acquisition was handled using Hypack software and the Applanix POSMV.

## 4.4 Survey Lines

### 4.4.1 Multibeam

As previously described, multibeam data was collected to achieve 100% bottom coverage with 20% overlap for seabed morphology. Lines were run to ensure the full extents of the boundary were covered with multibeam sounding data. Line spacing was determined by depth. The density (soundings per node) or a 1x1 meter grid ranges from at least 1 sounding per node to over 40 soundings per node with a mean sounding density of 8 soundings per node. Due to a change in RPL in July 2018, the area to be surveyed was revised and a new line plan around the updated RPL was created.

### 4.4.2 Sediment Samples

Sediment grab samples were collected at 500m intervals along the proposed cable alignment.

### 4.4.3 Sidescan Sonar

As previously described, sidescan sonar data was collected to achieve 100% bottom coverage with 20% overlap for seabed morphology and object detection of any object larger than 1m by 1m by 1m. Lines were run to ensure the full extents of the boundary were covered with multibeam sounding data. Line spacing was determined by depth. Lines parallel with the RPL were run with 80m spacing and 100m range set on the side scan for 20% overlap. In shallow section less than 10m, line spacing of 60m was run parallel with the shoreline and the range set to 100m. All lines were run a set speed between 2-4 knots to maintain data density while maintaining the system flying above the seafloor.

### 4.4.4 Sub-bottom

As previously described, sub-bottom profiler files were collected along transects spaced at 80 meter intervals from the RPL to determine thickness and nature of the sediments. The centerline was run twice with parallel lines at 80, 160, and 240 m either side of the RPL. All lines were run at a set speed between 4-5 knots to maintain data density.

### 4.4.5 Magnetometer

As previously described, magnetometer data was acquired along the same planned lines parallel with the RPL as the side scan sonar. The magnetometer was not run on the shoreline shallow passes All lines were run at a set speed of 2-4 knots so that the system flew at the same offset length behind the vessel throughout the survey.

## 4.5 Geodesy

### 4.5.1 Project Coordinates

The project coordinates used for the survey were a custom Mercator projection supplied by Fugro. The units employed were in meters. The geodesy parameters can be found below as well in the mobilization report. The parameters were confirmed on June 1st 2018 with reference to two test points in Fugro Starfix.

| **Global Navigation Satallite System (GNSS) Geodetic Paramaters** | | |
|---|---|---|
| Datum: | Wold Geodestic System 1984 (WGS84) | |
| Ellipsoid: | World Geodetic System 1984 | |
| Semi-major Axis: | a = 6 378 137.000 m | |
| Inverse Flattening: | 1/f = 298.257 223 563 | |
| Local Datum Geodetic Parameters | | |
| Datum: | Wold Geodestic System 1984 (WGS84) | |
| Ellipsoid: | World Geodetic System 1984 | |
| Semi-major Axis: | a = 6 378 137.000 m | |
| Inverse Flattening: | 1/f = 298.257 223 563 | |
| **Datum Transformation Parameters from WGS84 to WGS84 - Coodinate Frame Rotation Convention** | | |
| Shift dX: 0 M | Rotation rX: 0 M | Scale Factor: 0 ppm |
| Shift dY: 0 M | Rotation dY: 0 M | |
| Shift dX=Z: 0 M | Rotation dX=Z: 0 M | |
| **Project Projection Parameters** | | |
| Map Projection: | Mercator | |
| Latitude of Origin: | 35° 00' 00" N | |
| Longitude of Origin: | 175° 00' 00" E | |
| False Easting: | 8 000 000 m | |
| False Northing: | 6 000 000 m | |
| Scale Factor | 1 | |
| Units | International Meters | |

| **Name: WGS 84 / Mercator [Fugro]** | | |
|---|---|---|
| ESPG Code | Fugro::986551161 | |
| **Local Geodetic Datum Parameters** | | |
| Datum | World Geodetic System 1984 | EPSG::6326 |
| Ellipsoid: | WGS 84 | |
| Semi-major Axis: | a = 6 378 137.000 m | |
| Inverse Flattening: | 1/f = 298.257 223 563 | |
| **Datum Transformation Parameters from WGS84 to WGS84** | | |
| X-axis translation 0m | X-axis rotation 0 " | Sclae difference 0 ppm |
| Y-axis translation 0m | Y-axis rotation 0 " | Coodinates Frame rotation |
| Z-axis translation 0m | Z-axis rotation 0 " | EPSG::0 |
| **Project Projection Parameters** | | |
| Map Projection: | Mercator | |
| Grid System | Mercator | EPSG::19884 |
| Reference Latitude/Latitude of Origin: | 35° 00' 00" N | |
| Central Meridian | 175° 00' 00" E | |
| False Easting: | 8 000 000 m | |
| False Northing: | 6 000 000 m | |

Figure 16: Geodesy Parameters as used for the project

It should be noted that these parameters differ from those in document “P03437 - HKA - Inshore Survey in CA - 14 May 2018.pdf” Internal kick off meeting which employs a scale factor at the standard parallel.

### 4.5.2 Vertical Datum

Survey data was vertically referenced to LAT. MLLW tide data were downloaded from the local NOAA tide gauge 9416841, Arena Cove CA. These data were applied to the vessel position and a fixed 0.667 meter offset was applied to the MLLW data to correct it to the desired LAT vertical datum. The conversion from MLLW to LAT is based on the datum elevations as published by NOAA at the tide gauge. This is shown below in Figure 17 Datum conversion at NOOA tide station Point Arena.

**Elevations on Mean Lower Low Water**

**Station:** 9416841, Arena Cove, CA
**T.M.:** 0
**Status:** Accepted (Dec 6 2011)
**Epoch:** 1983-2001
**Units:** Meters
**Datum:** MLLW
**Control Station:** 9415020 Point Reyes, CA

| Datum | Value | Description |
|---|---|---|
| MHHW | 1.787 | Mean Higher-High Water |
| MHW | 1.583 | Mean High Water |
| MTL | 0.968 | Mean Tide Level |
| MSL | 0.957 | Mean Sea Level |
| DTL | 0.894 | Mean Diurnal Tide Level |
| MLW | 0.352 | Mean Low Water |
| MLLW | 0.000 | Mean Lower-Low Water |
| NAVD88 | 0.039 | North American Vertical Datum of 1988 |
| STND | -8.822 | Station Datum |
| GT | 1.787 | Great Diurnal Range |
| MN | 1.232 | Mean Range of Tide |
| DHQ | 0.204 | Mean Diurnal High Water Inequality |
| DLQ | 0.352 | Mean Diurnal Low Water Inequality |
| HWI | 6.840 | Greenwich High Water Interval (in hours) |
| LWI | 0.510 | Greenwich Low Water Interval (in hours) |
| Max Tide | 2.639 | Highest Observed Tide |
| Max Tide Date & Time | 02/06/1998 14:36 | Highest Observed Tide Date & Time |
| Min Tide | -0.805 | Lowest Observed Tide |
| Min Tide Date & Time | 05/18/2003 14:48 | Lowest Observed Tide Date & Time |
| HAT | 2.330 | Highest Astronomical Tide |
| HAT Date & Time | 12/31/1986 18:06 | HAT Date and Time |
| LAT | -0.667 | Lowest Astronomical Tide |
| LAT Date & Time | 05/25/1990 13:36 | LAT Date and Time |

Figure 17 Datum conversion at NOOA tide station Point Arena

### 4.5.3 Horizontal and Vertical Control

During acquisition R/V 505 and M/V Jab received DGPS corrections via an MBX4 Beacon and supplied position and orientation updates to the software through a network connection. The corrections supplied by the MBX4 were monitored during data acquisition to ensure differential signal was maintained throughout the survey. Position data on WAM-V was logged and a post processed position was used for the horizontal position of the vessel.

## 4.6 Acquisition and Safety

All data was collected between June 17th 2018 to June 21st 2018, July 5th, July 6th and August 26th to 30th 2018. Data was collected in a safe and efficient manner. All personnel involved with the project are OSHA certified. All personnel completed a Project Safety Orientation and Vessel Safety Briefing before being operations. At the start of the day and before any activity change a full toolbox talk was completed. The main risk involved was deploying and retrieving the towed survey instruments (SSS, SBP, and MAG). Two people were always on deck during these operations and retrieval and it was always done at periods during which ample time could be allowed for the process to be done in a safe manner.

## 4.7 Processing and Software

### 4.7.1 Multibeam Data

On the WAM-V and R/V 505 all multibeam data acquisition was completed in QPS QINSy hydrographic data acquisition and navigation software package. On M/V Jab Hypack was used to acquire all multibeam data. On all vessels position data was logged for the option of a PPK solution. Changes in the sound speed environment were monitored and appropriate actions in terms of further measuring of the water column sound speed were taken.
Data from WAM-V and R/V 505 was processed in QPS Qimera software. A post processed kinematic solution; smooth best estimate of trajectory (SBET) for the horizontal position of the vessel was created in Applanix POSPAC software and applied in Qimera to replace all online navigation and motion. Data from M/V Jab was processed in Hypack.

For all vessels, tidal data from NOAA tide station 9416841, Arena Cove, CA was used to reduce the data to datum MLLW. The data was further reduced to LAT using the given offset of 0.667m.

Additional checks and processing of sound velocity was completed in both software packages. Data was cleaned and analyzed on a 1mx1m dynamic surface (grid). Data was cleaned using slice sections and 3D point cloud views. Spurious sounds were deemed to be those which did not agree with the general surface and points which were not detected by two lines. In addition plumes of noise that can be recognized as sonar disturbance due to their shape were cleaned.

### 4.7.2 Sidescan Sonar Data

All sidescan data was processed in SonarWiz software. Data was corrected for layback based on the noted cable out and a caternary factor. Overlapping lines and targets were compared to quality control the layback adjustments made. Position data was filtered in order to account for GNSS errors or "jumps". Data was then bottom tracked, slant range corrected and a coverage mosaic created.
Each line was analyzed to generate targets and to attribute targets with measurements (length, width and description). Heights were analyzed using the object shadow from the sidescan imagery. The program logs JSF files as the raw data files and are processed through SonarWiz to generate CSF files.

### 4.7.3 Chirp Sub-bottom Data

Chirp JSF data was imported into SonarWiz. Navigation was filtered using a spline smoothing filter to account for GNSS positioning errors and represented the estimated course of the fish with layback. Gain adjustments were applied in order to enhance the data to identify changes in amplitude through the profiles. Data was then bottom tracked to determine the consistent range from the sonar to the seabed. Layback calibration was completed and quality controlled against features in the multibeam data.
Using the multibeam gridded data, the sub-bottom, bottom tracked data was aligned to the seabed. This processing step reduces the need for direct heave compensation of the sub-bottom data as the multibeam data is corrected for all motion artifacts. In addition, all depths below the seabed after aligning with the seabed are brought down to the LAT vertical datum so that any subsurface feature depth is absolute (related to LAT) as well as relative to the seabed.

Subsurface seismic units were identified and digitized in the chirp data using SonarWiz. Data was analyzed for parabolas in order to identify buried targets. Various time varying gain settings were used to enhance subsurface features. Contacts were picked by looking for parabolas and disturbance. Cross line intersections were viewed to confirm subsurface horizons, sediment facies and features on multiple lines. With no bore sampling data available a standard sound velocity of 1500m/s through the subsurface material was employed.

### 4.7.4 Magnetometer Data

Magnetometer JSF data was imported into SonarWiz. The position was cleaned and interpolated to eliminate position jumps. Magnetometer data profiles were analyzed for dipole wave forms. The profiles were analyzed in reference to the plan view map showing the cable locations. This analysis allowed the determination of whether the cable could be detected. A test object of known ferrous material was surveyed. This was used to confirm the ability of the sensor to detect ferrous objects. In addition the lines confirmed layback calculations and allowed the calibration of the system to determine correct Tesla ranges that could be observed over a cable.

# 5 RESULTS

## 5.1 Multibeam

100% multibeam coverage with 20% overlap was achieved through the entire survey area. Multibeam data was collected over the 500m wide corridor centered about the HKA Cable RPL to the BMH Manchester landing site both along the original and revised RPL.

Depths ranged from approximately 1.6m LAT on the landward end (KP 0.580) to 66.2m LAT on the seaward extents (KP 6.900) of the survey area. Data from the three vessels was combined. Data agreed within 10cms of each other. Spurious soundings were identified where two soundings from different passes were not in agreement. All position data was successfully collected and applied in processing. Data was successfully aligned to the LAT vertical datum using a continuous tide file and offset to LAT. MBES depth coverage from the combined datasets through the entire survey corridor is displayed in the image below in Figure 18.

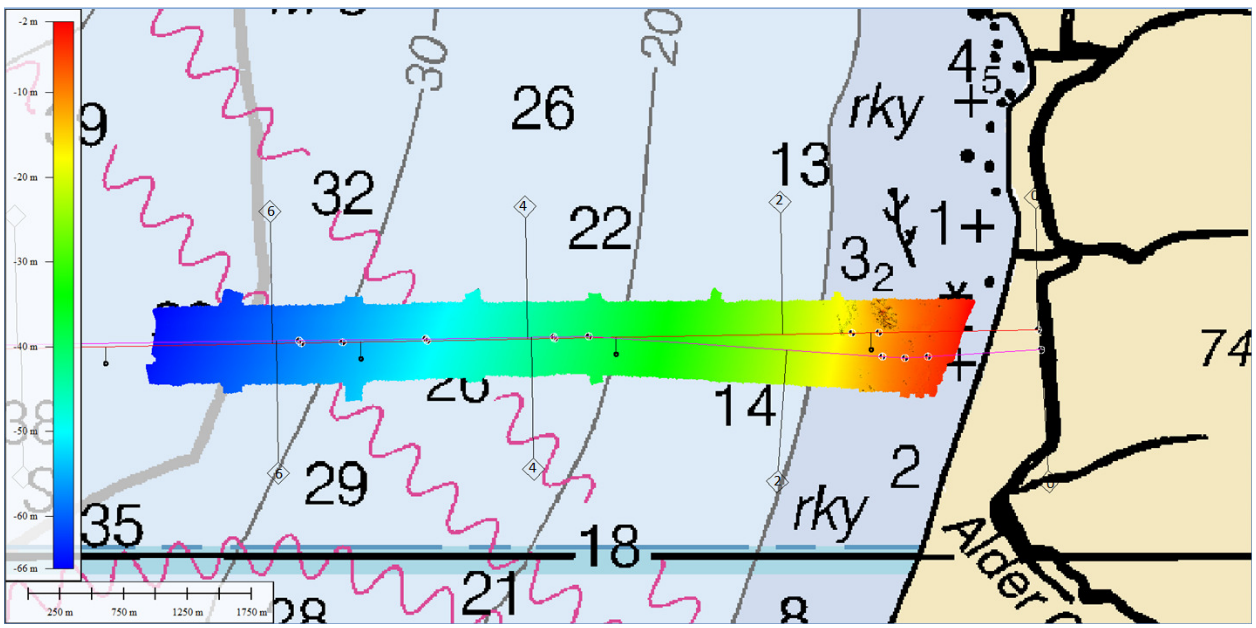



Figure 18: Multibeam Coverage

## 5.2 Sediment Samples

Thirteen (13) sediment samples were successful and sufficient material was collected in each to allow analysis. The completed bottom sample locations are displayed in the image below.

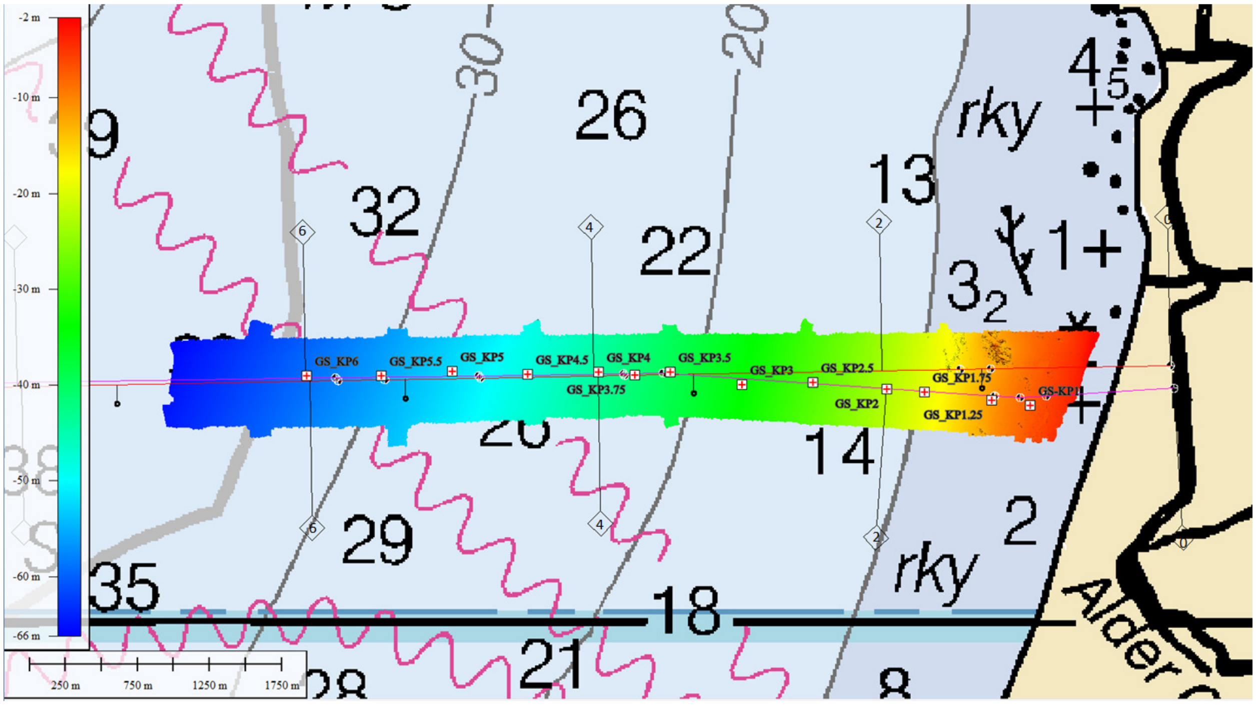



Figure 19: Sediment Grab Sample Locations (red crosses with sediment ID labeled)

Analysis was completed in the field with both color and grain size able to be determined.

An example of a logged sample can be found below in Figure 20.

eTrac

# FIELD SAMPLE LOG SHEET

PROJECT HKA MANCHESTER CABLE LANDING AREA

| | | | | | |
|---|---|---|---|---|---|
| Date | 8/30/2018 | Easting: | 13591109 | Water depth: 55.9m LAT | |
| Time (LT) | 15:12 | Northing: | 9851765 | Penetration: | |
| Sampling Method | Grab Sample | Latitude: | 39.015267 | Recovery: | |
| Sample No. | GS_KP5.5 | Longitude | 123.753193 | Logged by: | J. Coleman |


Comments: Very loose, silty sand. Large number of worms

Figure 20 Example of a logged soil sample in the site

The table below (Table 3) shows the results of the sediment sample recovery.

**Table 3: Sediment Sample Recovery**

| Sediment Sample Recovery | | | | |
|---|---|---|---|---|
| | | Fugro Custom Projection | | |
| ID | Sediment Sample Recovery | Easting | Northing | KP |
| GS-KP1 | Loose SAND | 13595853 | 9851551 | 1.06 |
| GS_KP1.25 | Very loose SAND | 13595573 | 9851587 | 1.32 |
| GS_KP1.75 | Very loose SAND | 13595077 | 9851649 | 1.82 |
| GS_KP2 | Very loose SAND | 13594804 | 9851670 | 2.00 |
| GS_KP2.5 | Very loose SAND | 13594261 | 9851717 | 2.53 |
| GS_KP3 | Very loose SAND | 13593744 | 9851702 | 3.05 |
| GS_KP3.5 | Very loose SAND | 13593221 | 9851790 | 3.58 |
| GS_KP3.75 | Very loose SAND | 13592961 | 9851770 | 3.84 |
| GS_KP4 | Very loose SAND | 13592694 | 9851795 | 4.00 |
| GS_KP4.5 | Very loose SAND | 13592178 | 9851776 | 4.51 |
| GS_KP5 | Very loose, slightly silty SAND | 13591625 | 9851800 | 5.07 |
| GS_KP5.5 | Very loose, silty SAND | 13591109 | 9851765 | 5.58 |
| GS_KP6 | Very loose, very silty SAND | 13590564 | 9851766 | 6.02 |

Surface classification was determined through Sidescan Sonar and sediment sample analysis. Sediment samples were used to ground truth data. An ASN client specific simplified classification scheme was used for analysis and charting. This grouped all sand types in to a Sand classification.

## 5.3 Sidescan Sonar

100% sidescan sonar coverage with 20% overlap was achieved through the entire survey area. Sidescan data was run simultaneously with MBES. Sidescan data was collected over the 500m wide corridor centered about the revised HKA Cable RPL to the BMH Manchester landing site. Data was acquired in depths ranging from 5m LAT to 64m LAT.

As described in the Mobilization report, lines were run for layback calibration. The layback calculation was performed using the position of the tow point sheave as the starting point. Layback of the tow fish was computed in SonarWiz software (caternary and cable incl.) using both physical measurements from the cable (alternating 2 and 3 meter markings) as well as an electronic hall effect sensor-based cable counter on a dedicated sheave. Electronic cable payout information was input in real-time via serial data to the acquisition computer and applied in the SonarWiz software. Layback calibration allowed for the position of the sidescan sonar to be accurate and consistent throughout the entire survey. All data was successfully QCed against the multibeam data. Data for the project was only acquired on M/V Jab.

The data density and coverage of sidescan sonar data allowed for the creation of a continues mosaic. Objects as small as 1x1x1m were able to be detected in the sidescan data. A sidescan sonar mosaic across the entire survey area is shown below in Figure 21.

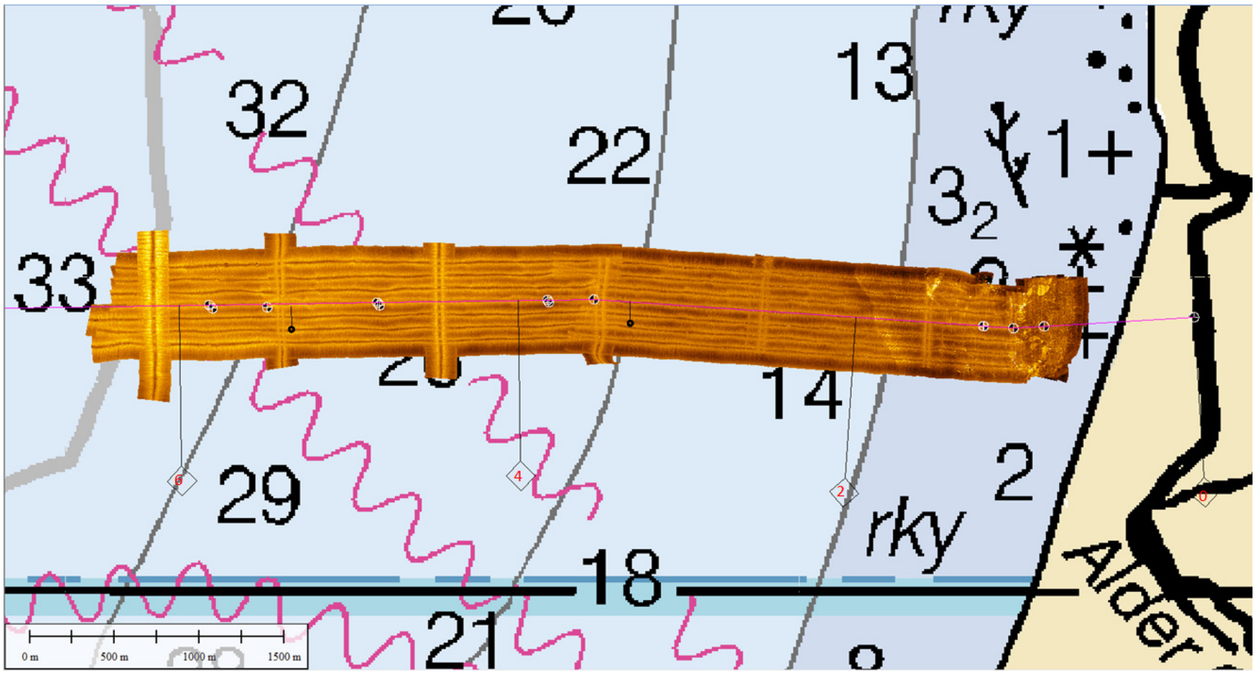



Figure 21 Sidescan data within the Manchester survey area

## 5.4 Sub-bottom

100% of planned survey lines were run. Thirty-eight (38) sub-bottom lines in total. Planned lines based on the original RPL were run on R/V 505. M/V Jab ran eight (7) planned lines centered around the revised RPL. Line files were divided at the RPL turn point. The lines covered the entire survey area. 80m spaced lines were run parallel to the Route Plan Line. The sub-bottom line coverage is shown below in Figure 22.

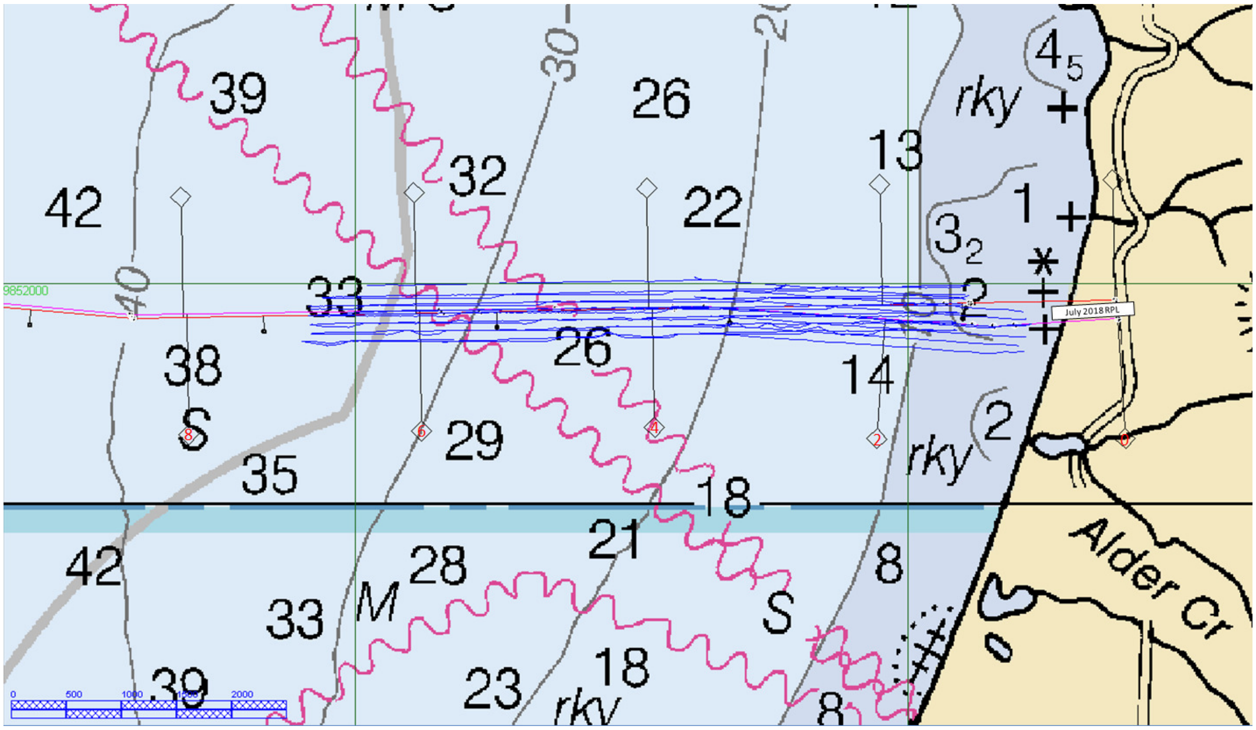



**Figure 22: Sub-Bottom Acquired Lines**

As described in the mobilization report, the sub-bottom profiler on R/V 505, the fish was towed using a fixed layback in the Discover software from the same tow point used for the sidescan sonar operations. On M/V Jab, the sub-bottom fish was towed from a cleat on the stern of the vessel at a consistent length behind the vessel.

The data was of good quality with no data gaps. Data was correctly aligned to datum successfully using the bathymetry grid from the multibeam data to reduce the data to absolute depth below LAT. Layback processing accurately positioned the fish and thus, the data. Surface detection data was cross checked against the multibeam data (see mobilization report for details).

The CHIRP frequency of 2-15 kHz, with a maximum ping rate of 10Hz of the system allowed for shallow subsurface stratification. The sample range for the system was adjusted along the planned lines to account for the differing seabed depths. The range was set to at least 10m below the first seabed return but a maximum of 20m. Penetration achieved was up to 10m. This is shown in Figure 23.

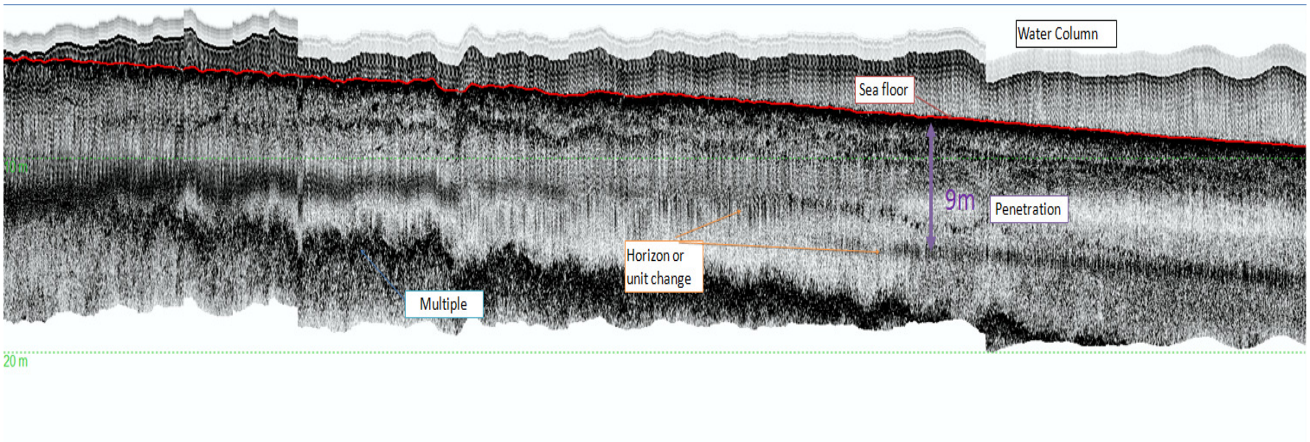



Figure 23 Example of penetration up to 9m

Stratification layers were evident and sediment facies were identifiable across the data. Six (6) types of subsurface facies were identified across the survey area. These were able to be digitized consistently across adjacent lines. Several subsurface isolated features were identified in the data. Signal return parabolas were evident in the data. Figure 24 below shows an example of subsurface sediment facies identified in Chirp sub-bottom data.

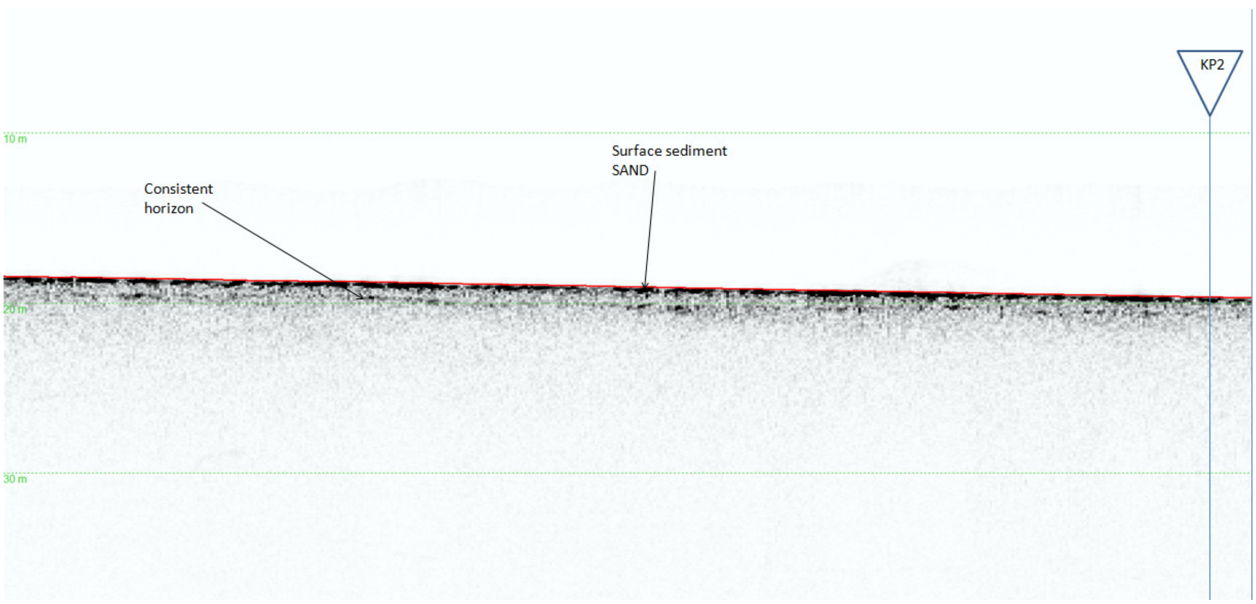



Figure 24: Subsurface Sediment Facies in Sub-bottom Data

Figure 25 below shows an isolated feature in the Chirp Sub-bottom data.

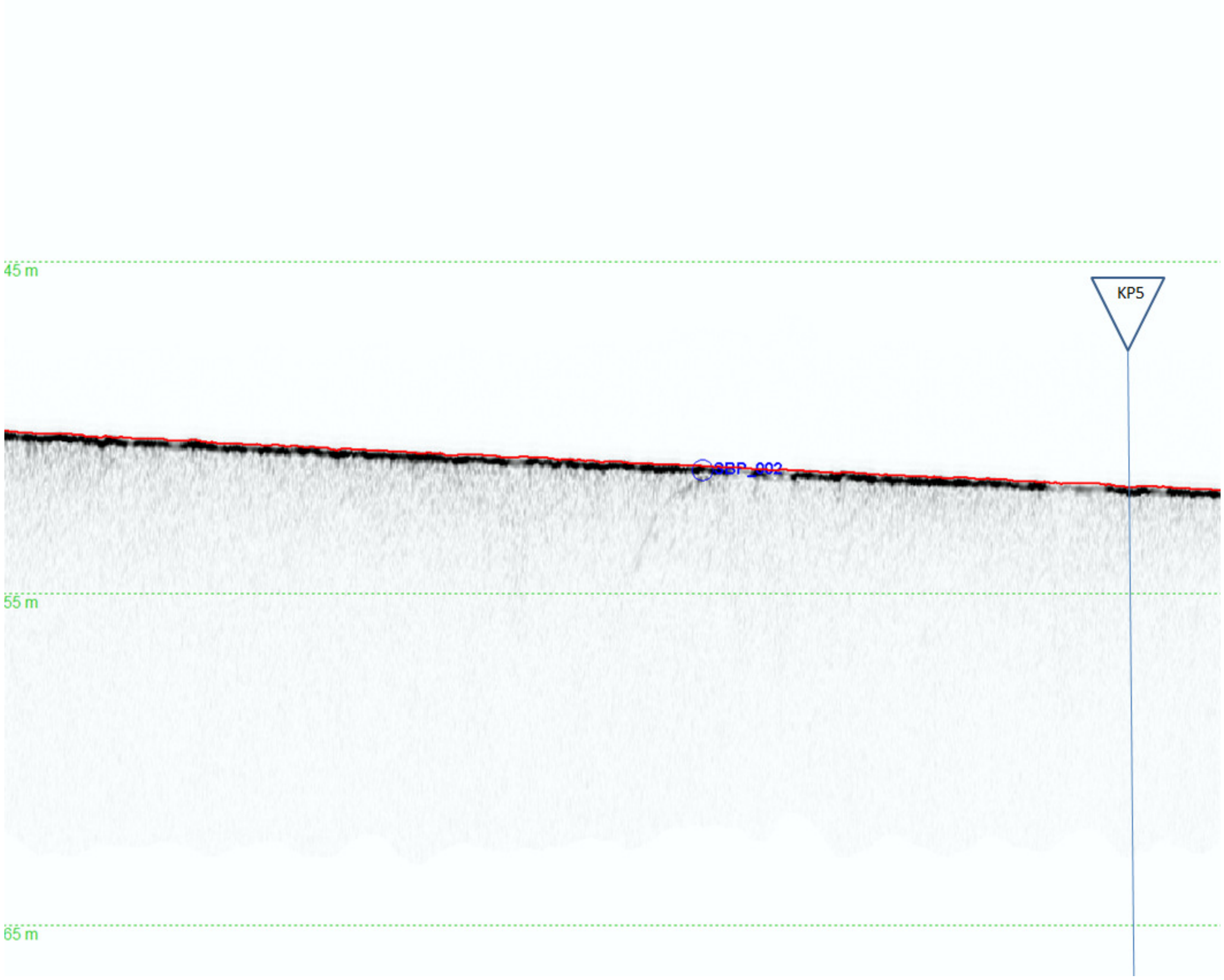



Figure 25: Isolated Feature Found in Sub-bottom Data

## 5.5 Magnetometer

100% of planned survey lines were run. Magnetometer lines were run along the same planned lines as the sidescan. The seven lines parallel to the RPL at 80m spacing and then the six (6) cross lines were run as with the side scan. This created twenty-one (21) data lines. As described in the mobilization report, layback of the magnetometer was computed as an offset of 9 meters from the sidescan position computed in the SonarWiz software. The measured offset and layback calibration of the SSS allowed the position of the magnetometer system to be accurate and consistent throughout the entire survey. Figure 26 below shows the magnetometer lines completed in the survey area.

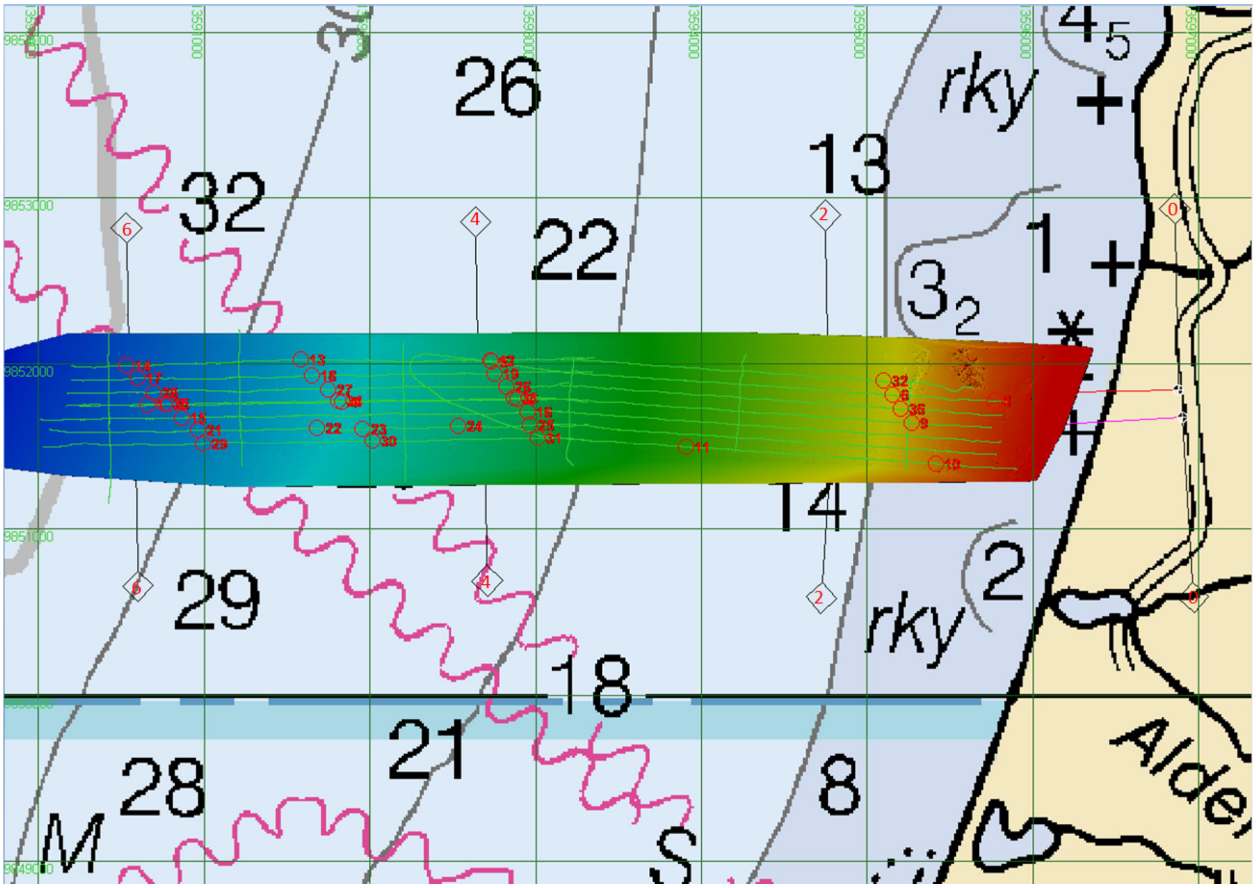



Figure 26: Magnetometer Lines Run

The positioning and detection of the ferrous object was accurate and consistent.  A test was completed during mobilization to confirm the ability to detect ferrous objects.  Several targets were noted in the data with the magnetometer detecting a charted cable.  An example of one detection point in the magnetometer data is shown below in Figure 27.

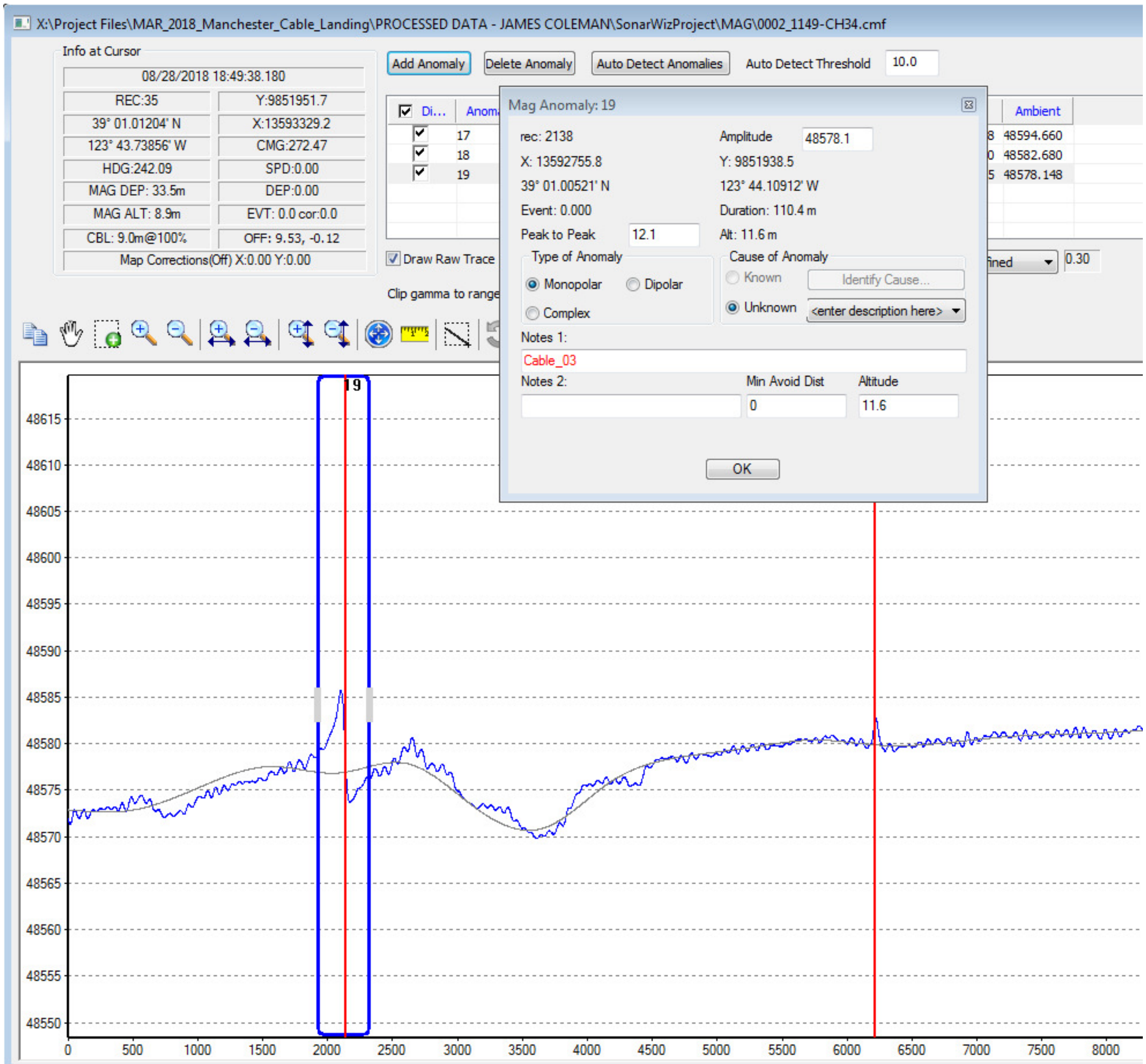



Figure 27: Magnetometer Profile over a Test Object Showing Detection

## 5.6 Overview

Surface objects and debris larger 1m x 1m in size were detected. Subsurface stratification and sediment facies were identified and located. Each sediment layer was classified and differentiated from each other. Sediment classification was also determined by sediment grab samples acquired every 500m along the center alignment of the survey area. Subsurface isolated features were identified in the sub-bottom sonar data. Cable crossing positions were located in the magnetometer data.

# 6 ANALYSIS

This section will describe the As Surveyed positions of surface and subsurface objects and the classification of surface sediment layers and subsurface sediment units. Surface and subsurface objects were categorized based on object type. The location of each feature in the analysis sections below are referenced to Kilometer point (KP) and Distance Cross Course (DCC) based on the RPL from the client file "HKA_SEG5_MANCHESTER TO BU4_RPL_PSR01_18-JULY-2018.dwg".

## 6.1 Bathymetry

The bathymetry in the area ranges from 1.6m below LAT at shore to a maximum depth of 66.2m offshore. The bathymetry undulates downward from shore to offshore. The slope is an average of 0.5° and consistently between 0.2 and 0.6°aside from the section between KP 1 and 1.5 where the maximum slope is 0.9°. An overview of the bathymetry is shown below in Figure 28.

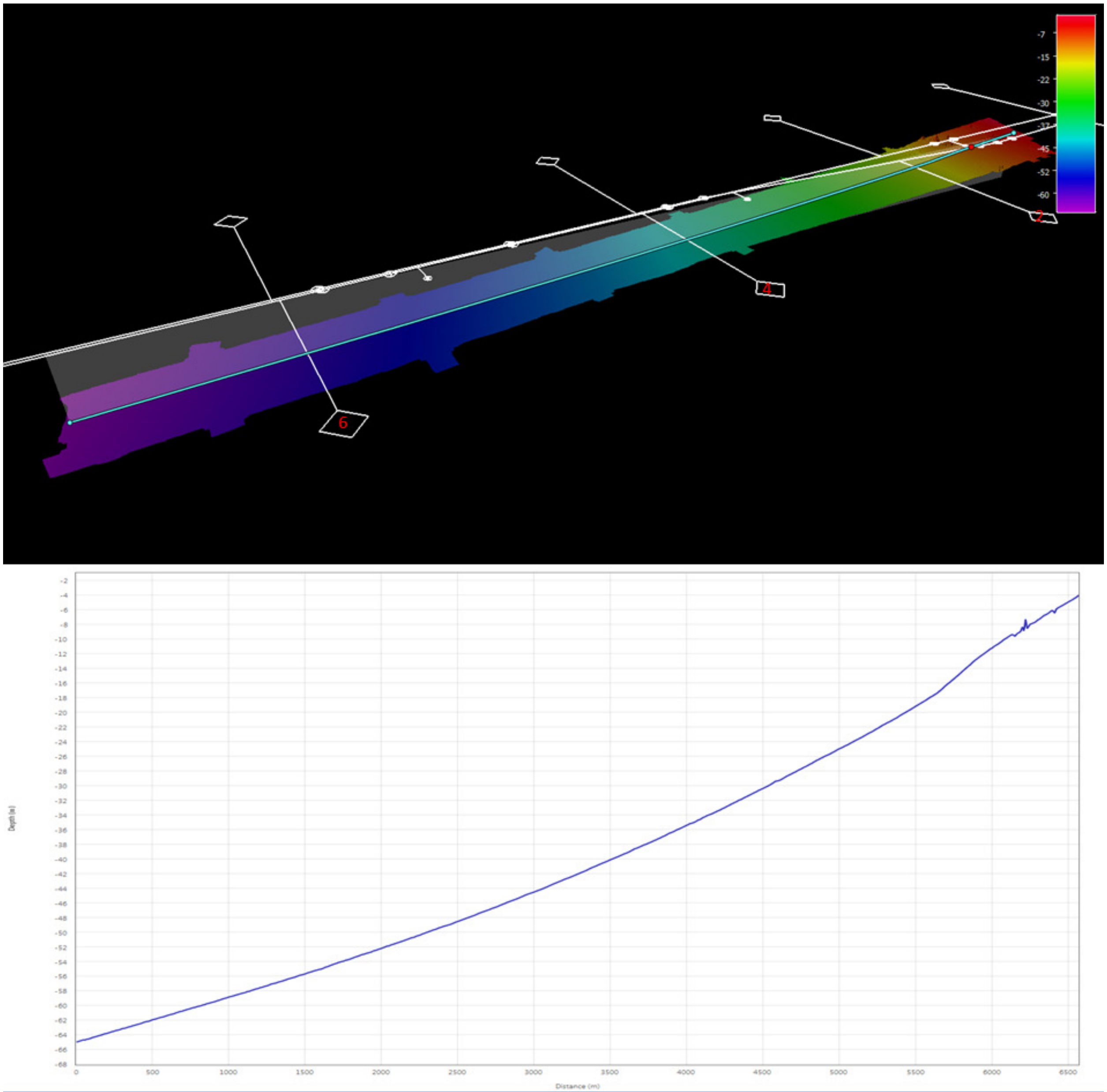



Figure 28 Overview of the bathymetry across the survey area with profile (vertical exaggeration x 6)

Rock outcroppings between KP0.8 and 1.8 are apparent in the area creating more local, uneven bathymetry and steep slopes up to 5° (see Figure 29 below).

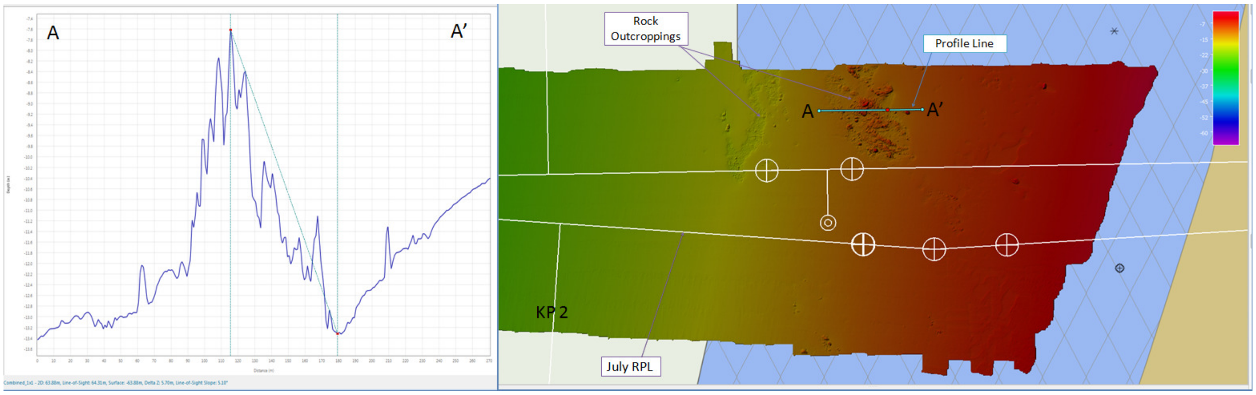



Figure 29: Rock outcroppings in MBES Data

## 6.2 Surface Classification

This section details the classification of the surface sediment and substrate. The entire area was able to be grouped into two classifications; 1) Sand 2) Rock.

Rock substrate in rock outcropping formation is located between KP 0.8 and 1.8. The largest contiguous area of rock area within the survey area is 64,000 sq meters. The rock areas are shown below in Figure 30.

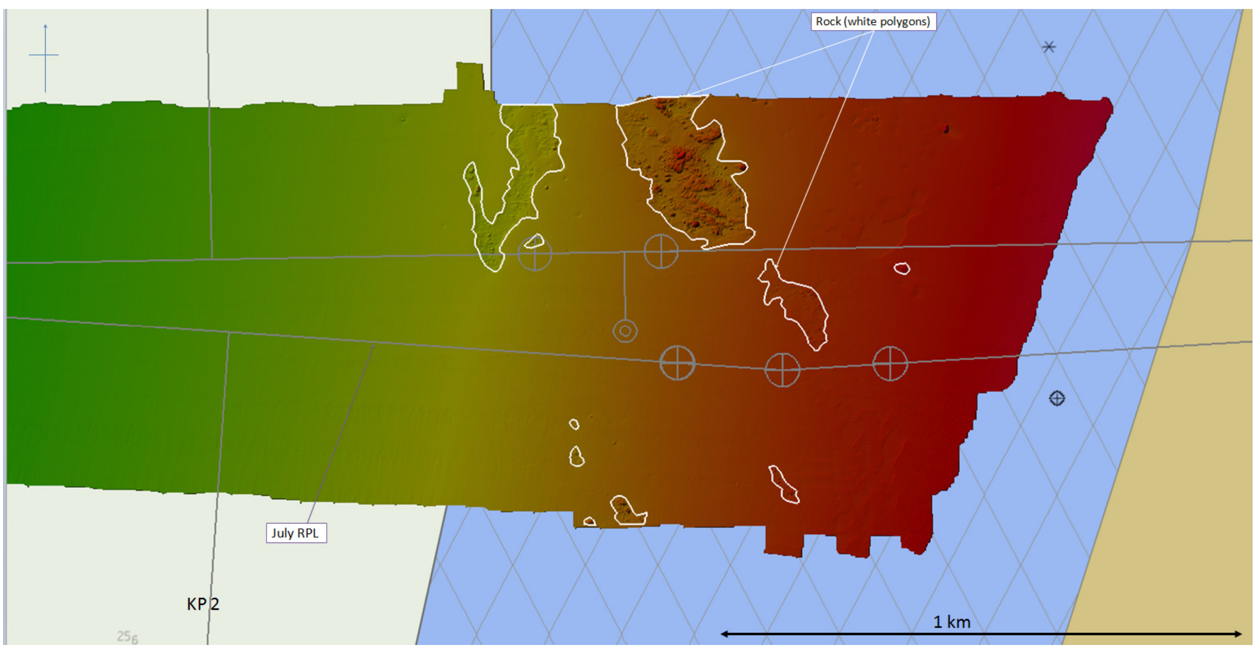



Figure 30: Rock areas

Sand was the only other surface sediment type identified.  Very loose, silty sand to loose granular sand was identified across the region.  The areas of sand and rock classification across the survey area and shown below in Figure 31 to Figure 34 with the sediment sample locations and descriptions over the side scan mosaic.

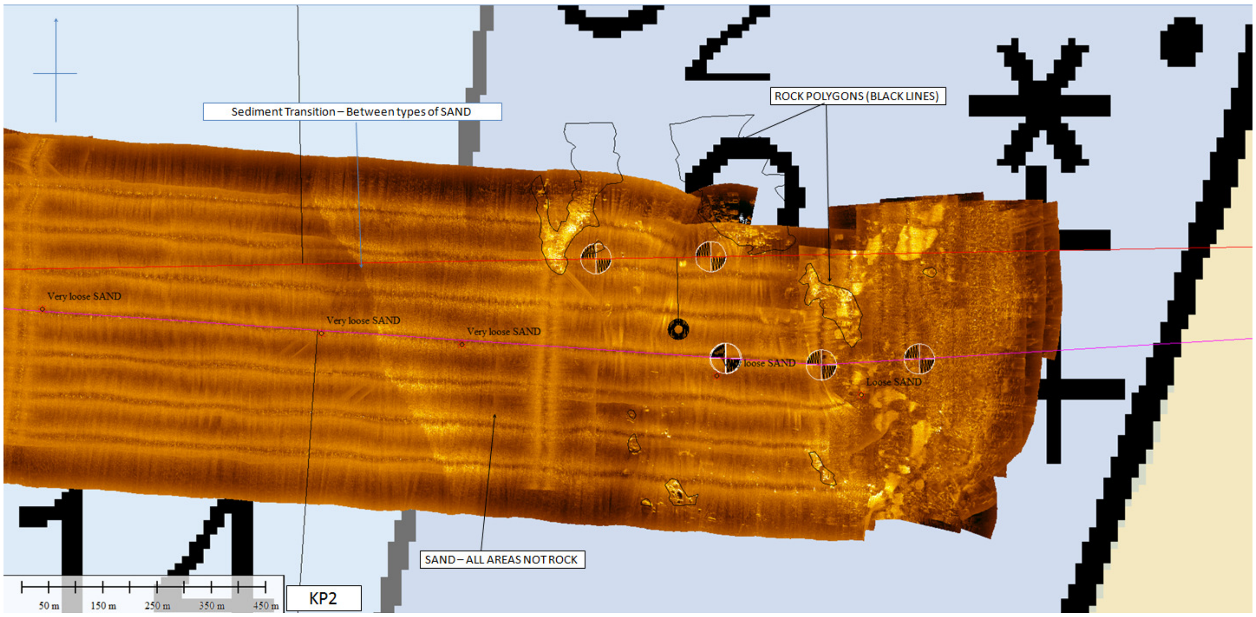



Figure 31 Sediment classification KP0 to 3 - Sand and Rock

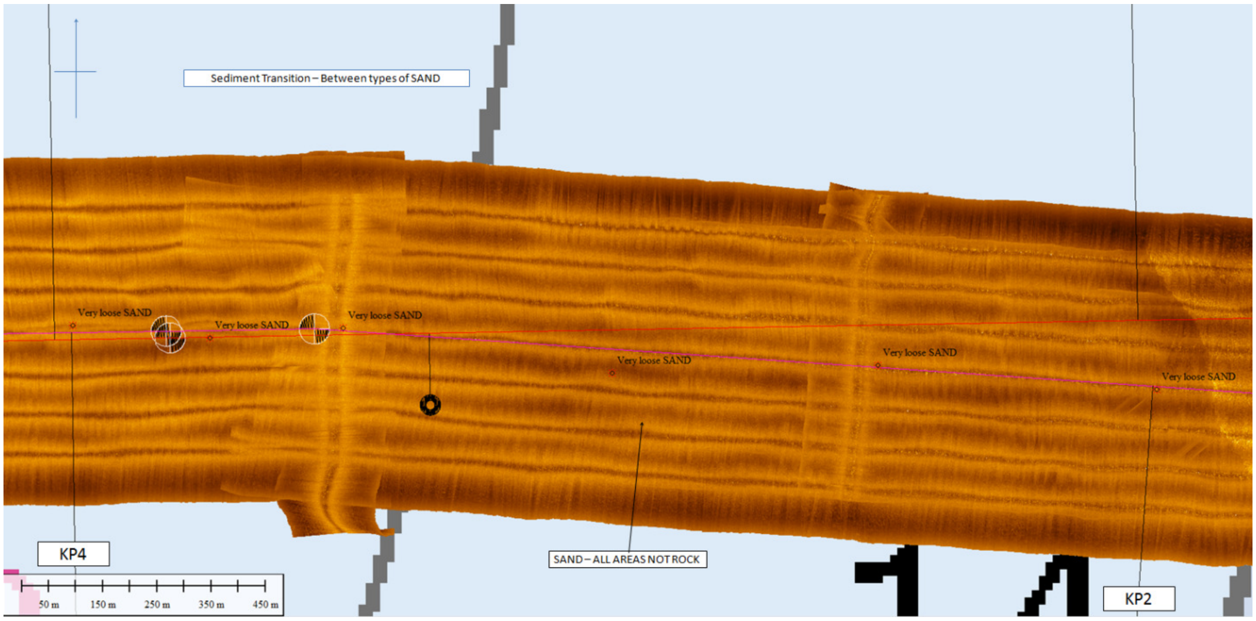



Figure 32 Sediment classification KP2 to 4 - Sand


Figure 33 Sediment classification KP4 to 6 - Sand

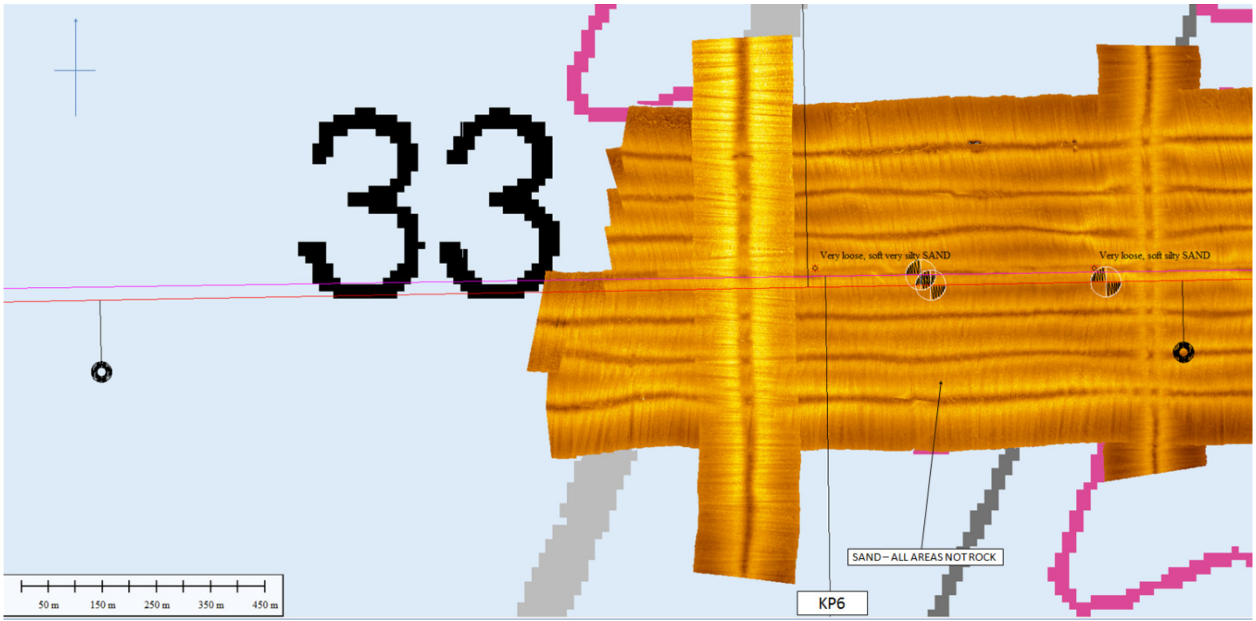



Figure 34 Sediment classification KP6 to 6.5 - Sand

## 6.3 Surface Geologic Features

The areas of rock are made up of rock outcropping features. These features protrude from the surrounding sand sediment surface by as much as 6m. A 3D surface view of the rock outcroppings is below in Figure 35 with a section across part of a rock outcropping showing dimensions.

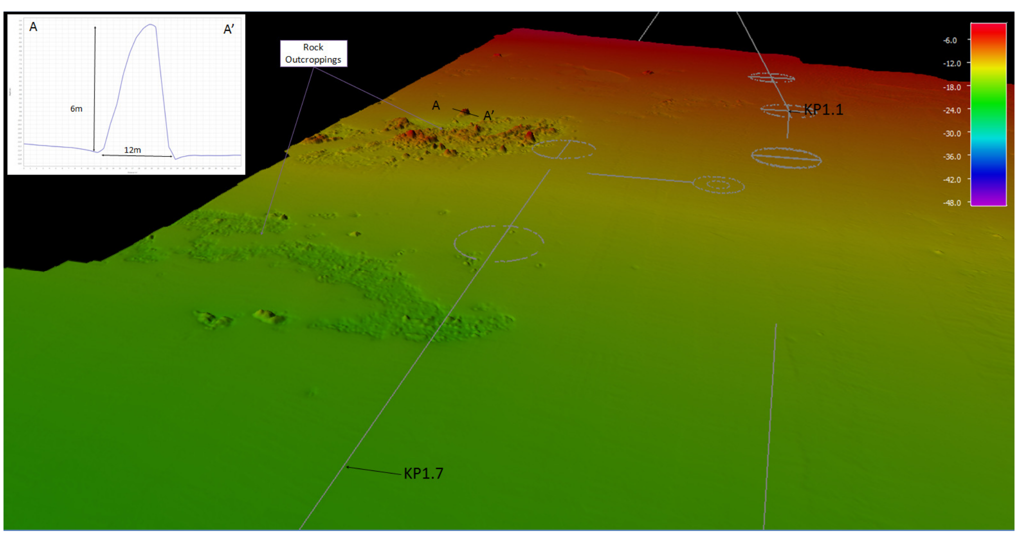



Figure 35 Rock outcropping in 3D surface view (no vertical exaggeration) with inset showing the dimensions of a section of the rock outcropping

In addition to large contiguous areas of rock there are smaller, sporadic islands of rock outcroppings in the shallower area of the survey between KP 0.8 and 1.2. A 3D surface view of these smaller rock out cropping areas is below in Figure 36.

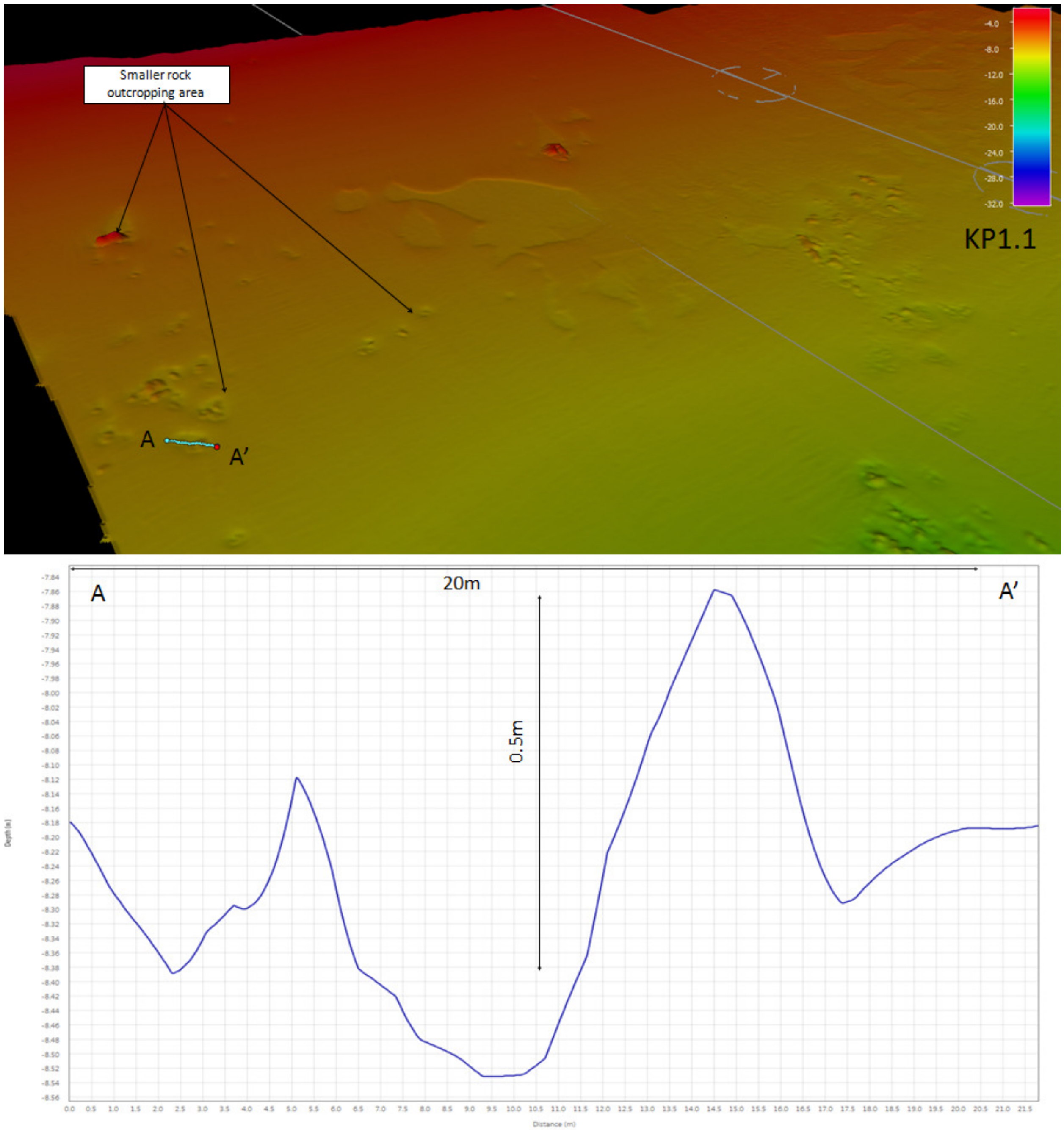



Figure 36 Smaller rock outcropping

The rock outcropping areas were clearly visible in the side scan data as shown below in Figure 37.

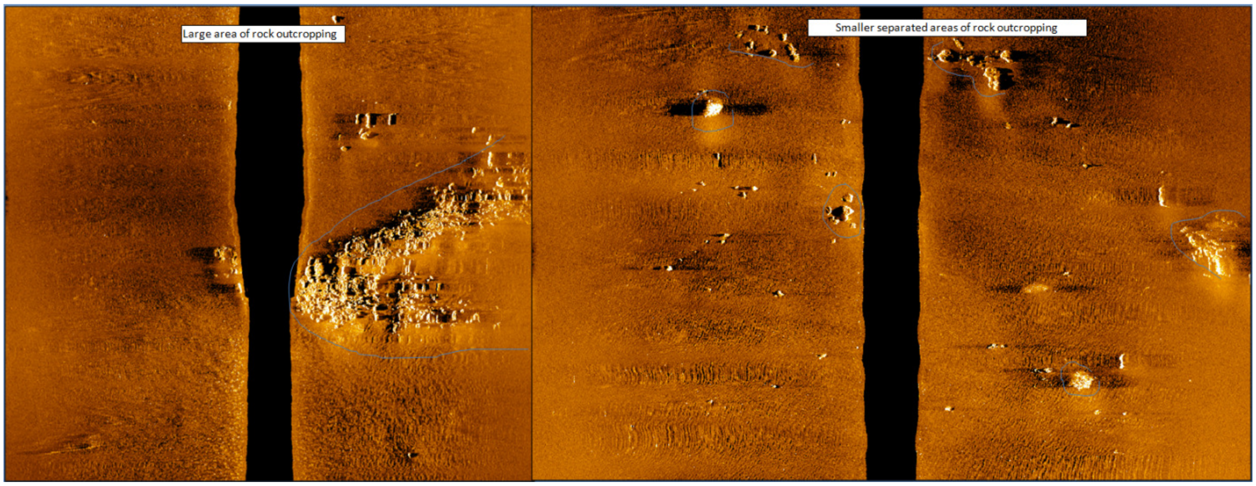



Figure 37 Rock outcropping in side scan data

Within the shallow areas classified as sand between KP0.5 and 1.1 are several similar depression features. These are between 25m and 50m wide. The depth change from the surrounding seafloor to the bottom of the depression feature is between 0.3m and a maximum 1.2m. They are irregular in shape. While other depression areas are associated with the rock outcroppings and scouring, there is no apparent feature creating these features. The location of these features is shown below in Figure 38.

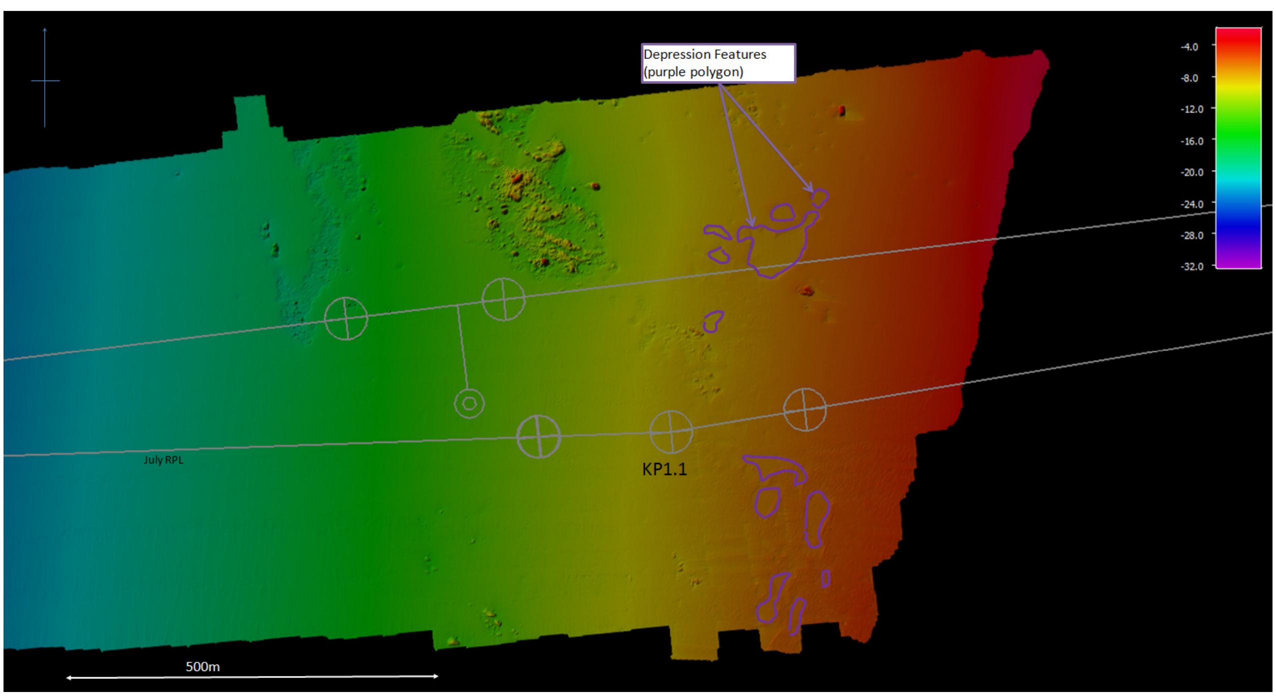



Figure 38 Location of the depression features

An image of these features with a cross section showing dimensions is below in Figure 39.

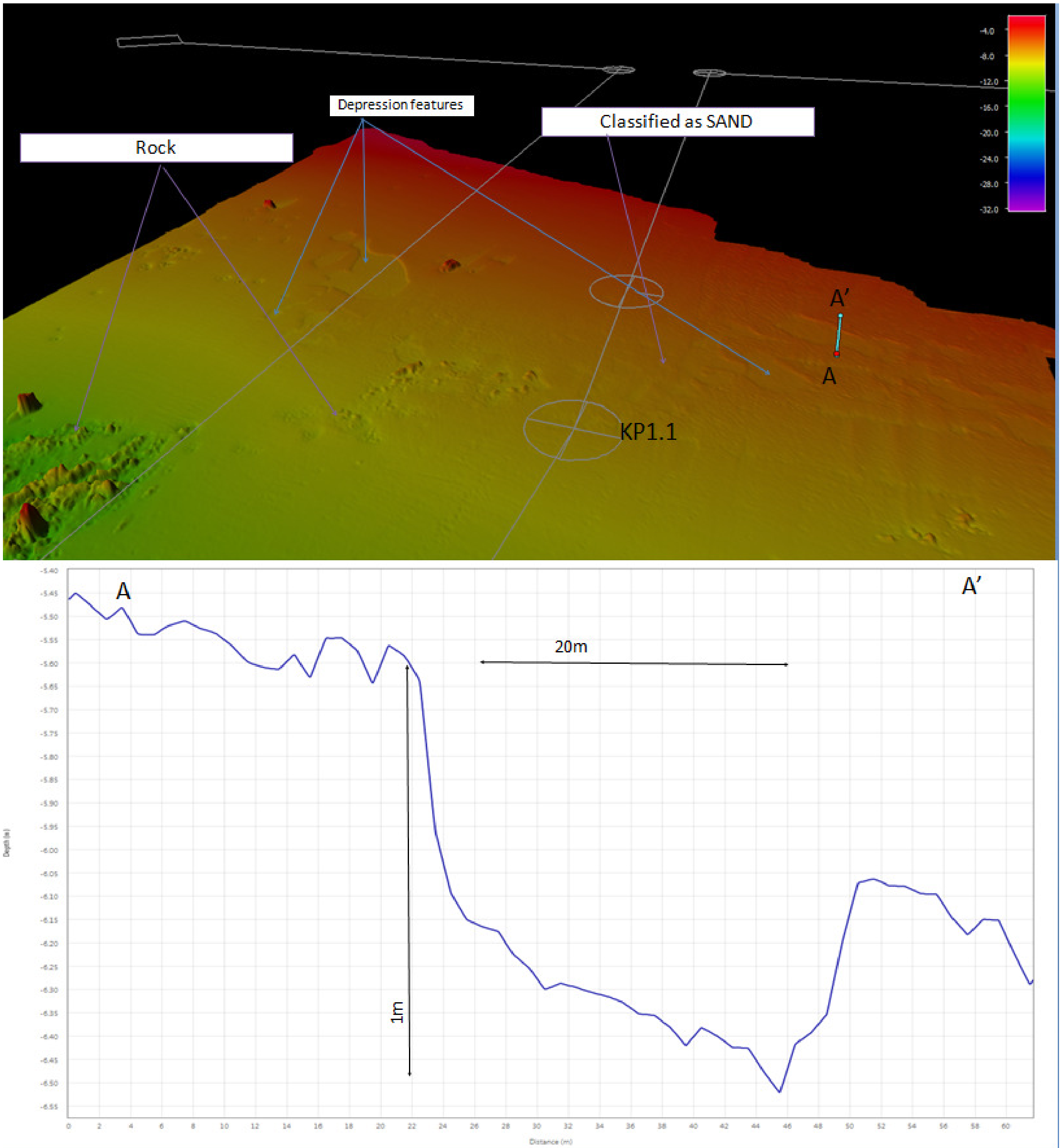



Figure 39 3D surface image of the depression features with a cross section showing dimensions

Within these depression features, in the side scan data small sand ripples were able to be identified. The extents of the sand ripples are shown below  in Figure 40 and correlate well with the depression features.

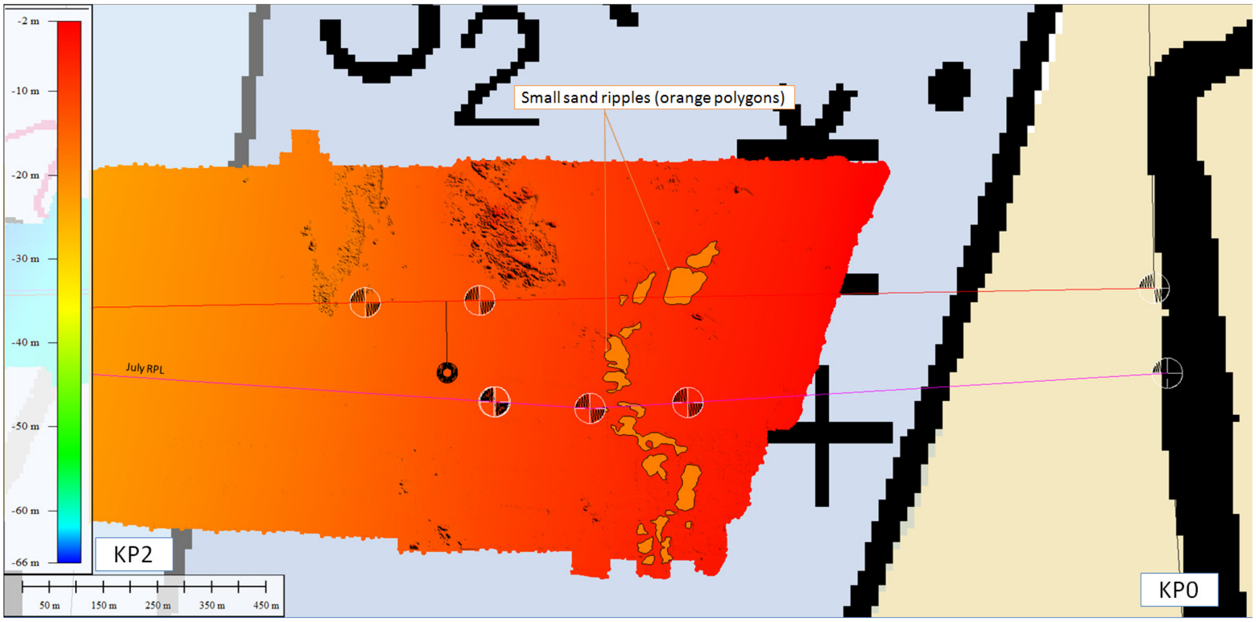



Figure 40 Areas of small sand ripples

The sand ripples within the depression features as seen in the side scan data are below Figure 41.

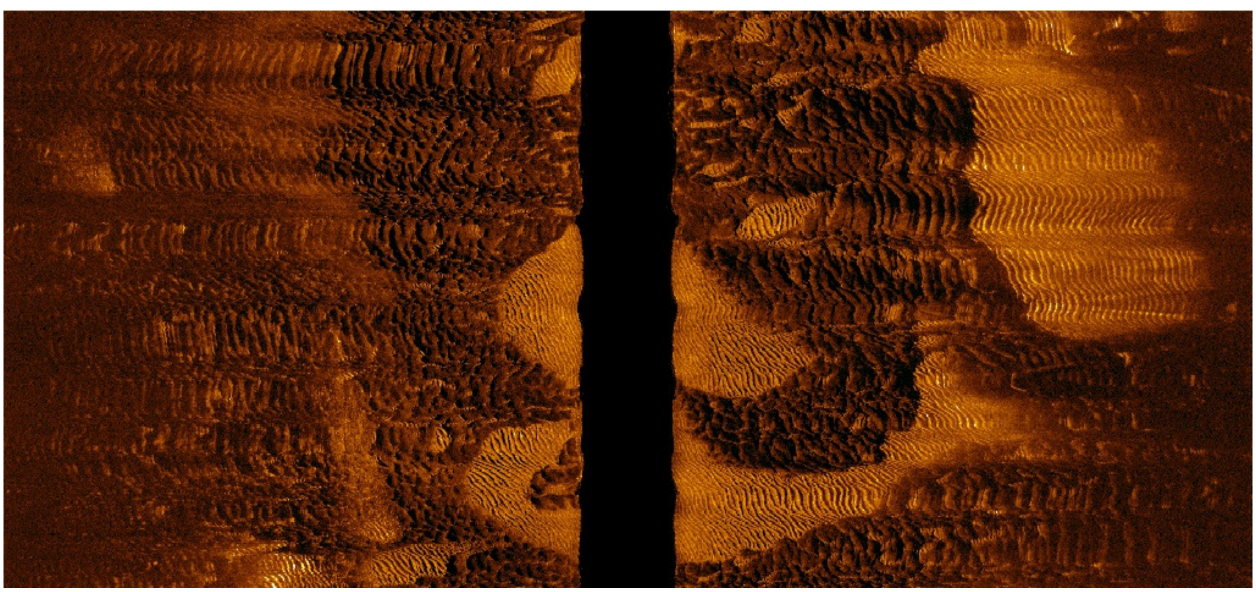


Figure 41 Sand ripples in the depression features as imaged in the side scan data

Sand ripples are also evident in scour areas associated with the rock outcroppings.  This is seen below in the side scan sonar data (Figure 42).

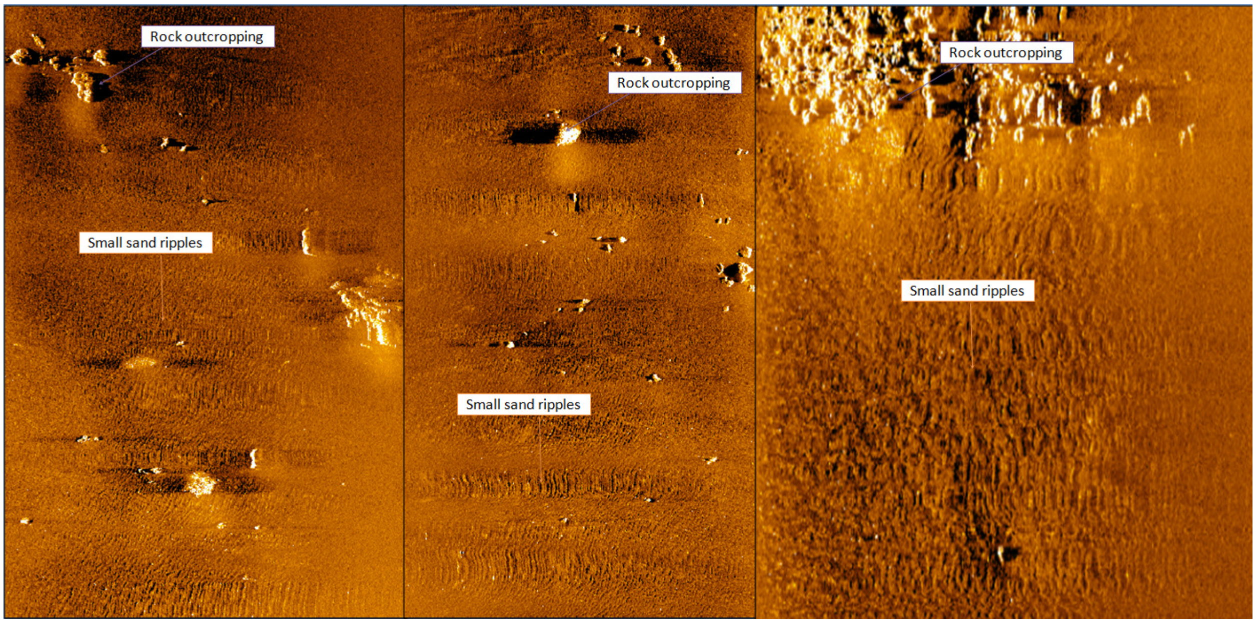



Figure 42 Sand ripples adjacent to rock outcropping features

A large contiguous area of sand dollars was identified across the survey area. The area is approximately 600m along the RPL from KP 1.4 to 2.0. The sand dollars created a particular spectrum signature in the side scan data and were then confirmed with sediment sample GS_KP1.75. The location of the sand dollar area with the eastern and western boundaries noted is shown below in Figure 43. The sand dollars as imaged in the side scan data are shown in Figure 44 and the sediment sample is below in Figure 45.

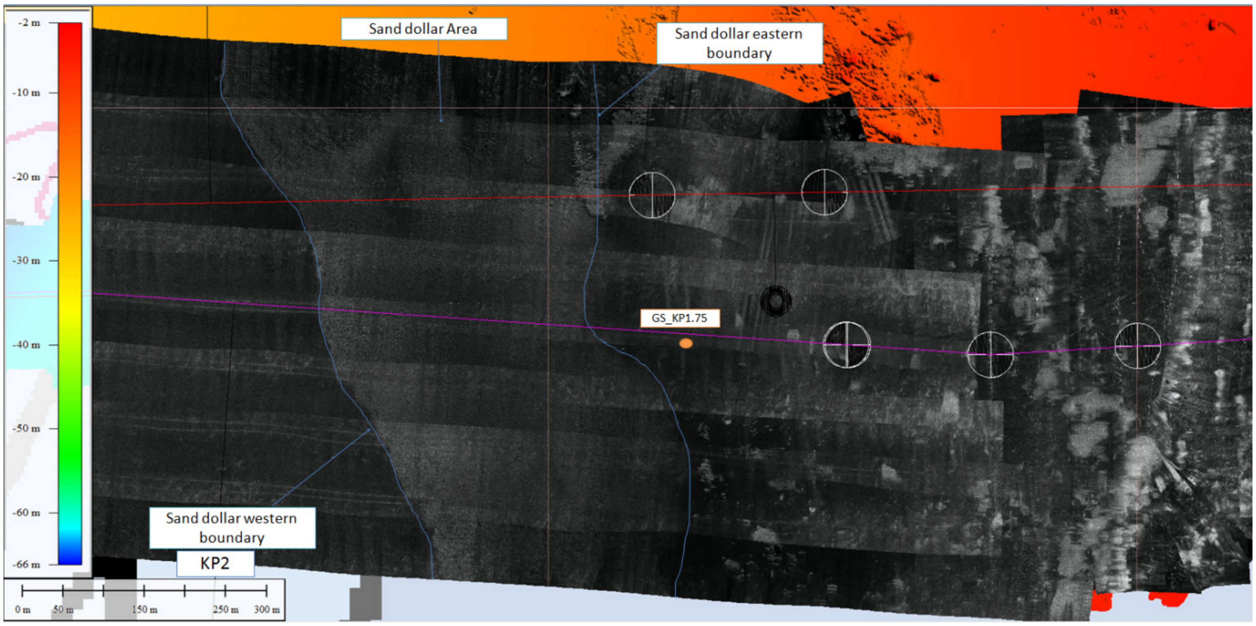



Figure 43 Sand dollar area with eastern and western boundaries

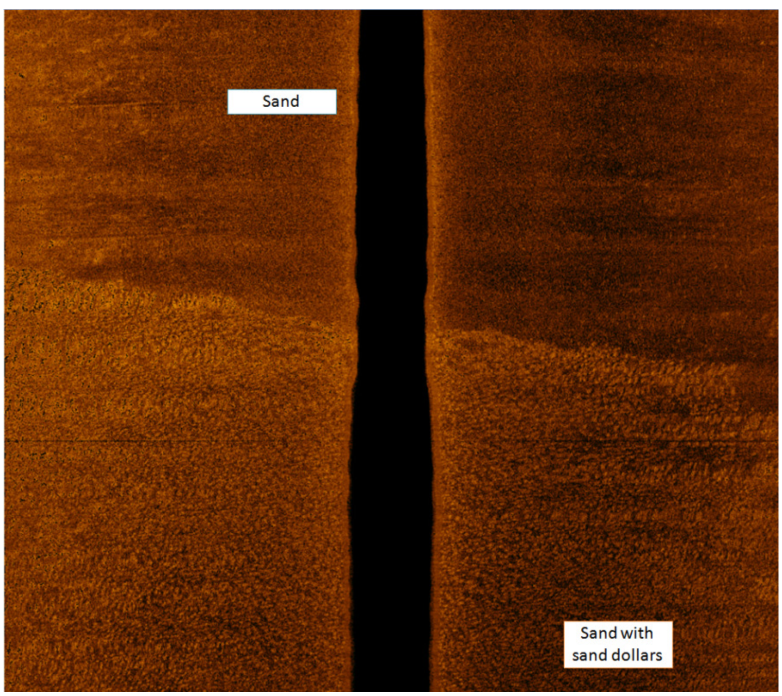


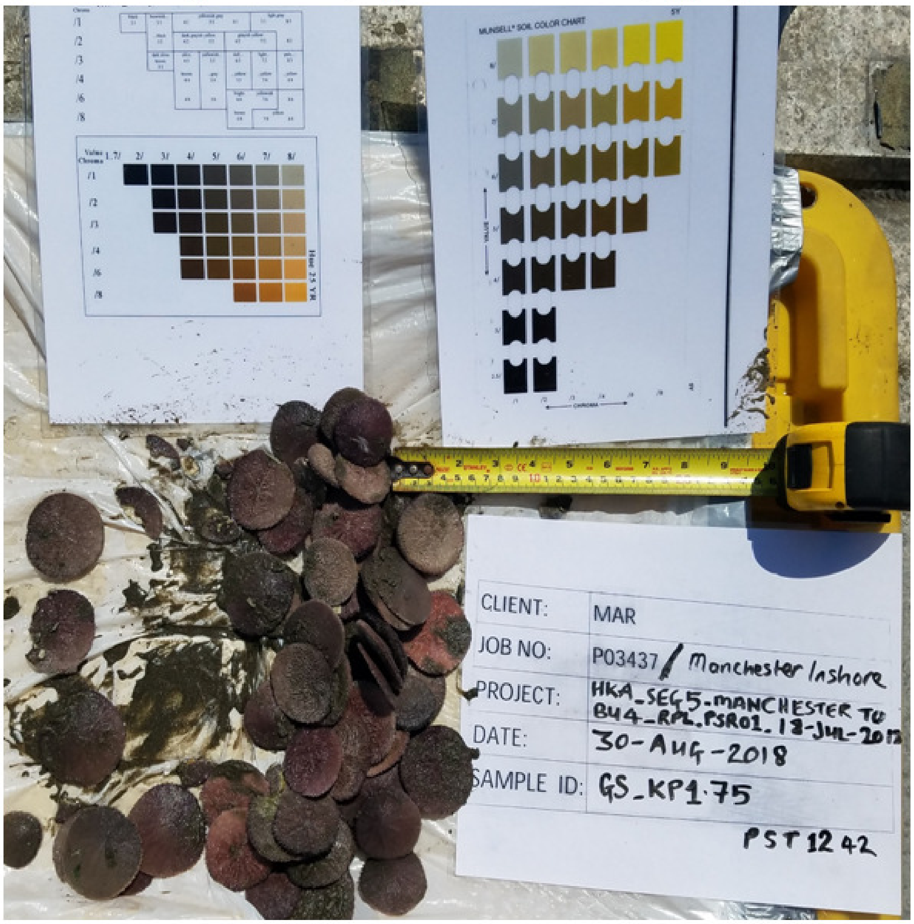

Figure 44 Sand dollars as imaged in the side scan data

eTrac

## FIELD SAMPLE LOG SHEET

PROJECT AREA HKA MANCHESTER CABLE LANDING

| | | | | | |
|---|---|---|---|---|---|
| Date | 8/30/2018 | Easting: | 13595077 | Water depth: | 19.7m LAT |
| Time (LT) | 12:42 | Northing: | 9851649 | Penetration: | |
| Sampling Method | Grab Sample | Latitude: | 39.014280 | Recovery: | |
| Sample No. | GS_KP1.75 | Longitude | 123.709722 | Logged by: | J. Coleman |




Comments: Large quantity of sand dollars. Grab unable to properly function due to sand dollars, most of sample lost. What remained was sand.

**Figure 45 Sediment sample GS_KP1.75 with sand dollars present**

Although the sediment was classified throughout the survey as sand, there was an evident change in the sediment type around KP4.8 until KP6. This was not differentiated by the sediment samples, but the signal return in the side scan was noticeable different. The location of the sediment change boundary is shown below in Figure 46. The change as seen in the side scan data is shown in Figure 47.


Figure 46 Location of the offshore sediment change boundary

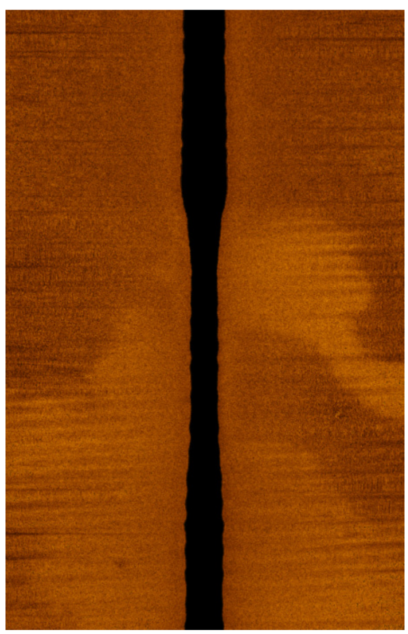


Figure 47 The sediment change boundary as imaged in the side scan sonar

## 6.4 Surface Objects

Using SSS, the survey area was analyzed for surface objects larger than 1mx1m1m within the given survey area limits. Eight (8) objects with a strong return were found in the survey area. These are classified as either unknown objects or unknown linear objects. The largest object is a linear object that is 4.8m long (0004_002). All other objects were between 0.7m and 3m in the longest dimension. The object listing is below in Table 4 with locations on a map in Figure 48. Images of the objects as seen in the side scan sonar data are below (Figure 49 to Figure 51).

**Table 4: Sidescan Sonar Contacts**

| Object ID | Coordinates (Easting, Northing) | | Coordinates (Latitude, Longitude) | | KP | DCC | Max Dimensions LxWxH (meters) | Description | Line Name |
|---|---|---|---|---|---|---|---|---|---|
| 0004_001 | 13593009.32 | 9851837.186 | 39;00.9532501 N | 123;43.9425163 W | 3.8 | 51.5 | 1.6x0.2x0 | Linear object | 0004_1606 |
| 0004_002 | 13592779.18 | 9851839.244 | 39;00.9543053 N | 123;44.0937780 W | 4.29 | 57 | 4.8x0.8x0.08 | Linear object | 0004_1606 |
| 0004_006 | 13590980.81 | 9851748.73 | 39;00.9078941 N | 123;45.2757734 W | 5.71 | 6.8 | 1.0x0.5x0 | Unknown object | 0004_1606 |
| 0005_002 | 13591724.17 | 9851650.262 | 39;00.8574039 N | 123;44.7871931 W | 4.97 | 116.2 | 2.0x1.3x0 | Unknown object | 0005_1118 |
| XL2_001 | 13591228.72 | 9851809.587 | 39;00.9390987 N | 123;45.1128323 W | 5.46 | 50.4 | 1.7x0.5x0 | Unknown object | XL_Corr_2 |
| RD1_0007_001 | 13594919.91 | 9851474.519 | 39;00.7672887 N | 123;42.6867633 W | 1.97 | 192.5 | 2.0x0.5x0 | Unknown object | 000&_1346 |
| 0006_001 | 13592954.09 | 9851675.481 | 39;00.8703351 N | 123;43.9788167 W | 3.86 | 109.3 | 3.0x0.6x0 | Linear object | 0006_1221 |
| RD1_0001_001 | 13593582.9 | 9852053.975 | 39;01.0644071 N | 123;43.5655255 W | 3.24 | 294 | 0.8x1.2x0.2 | Unknown object | Line-0009 |

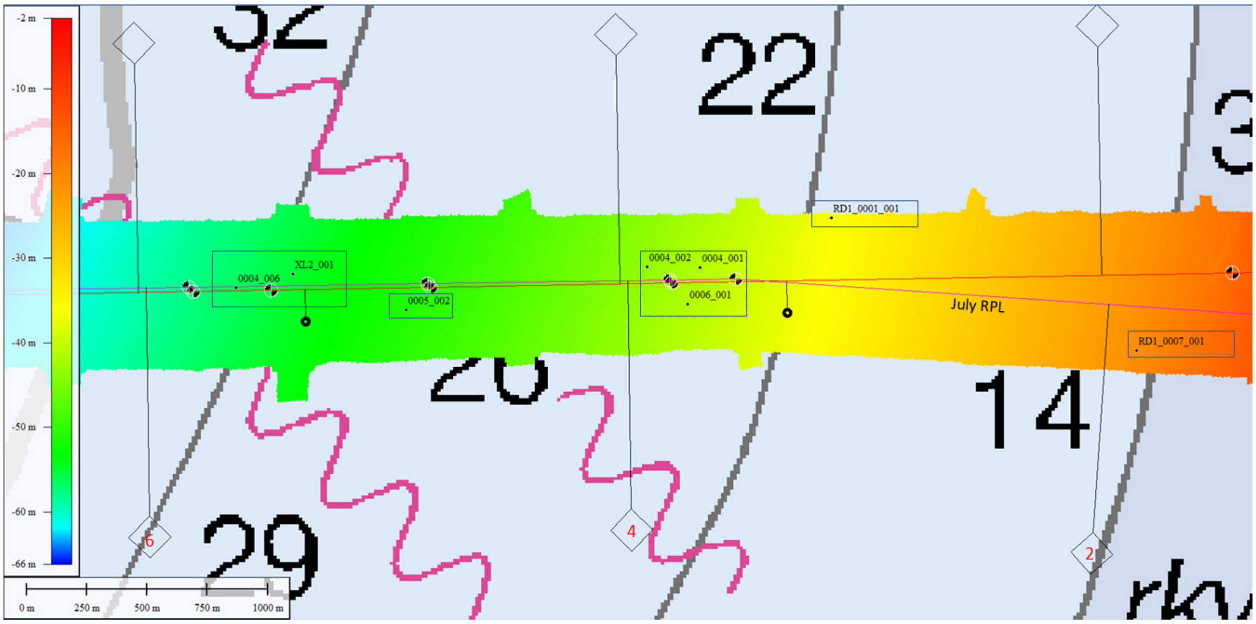



Figure 48 Location of surface objects identified

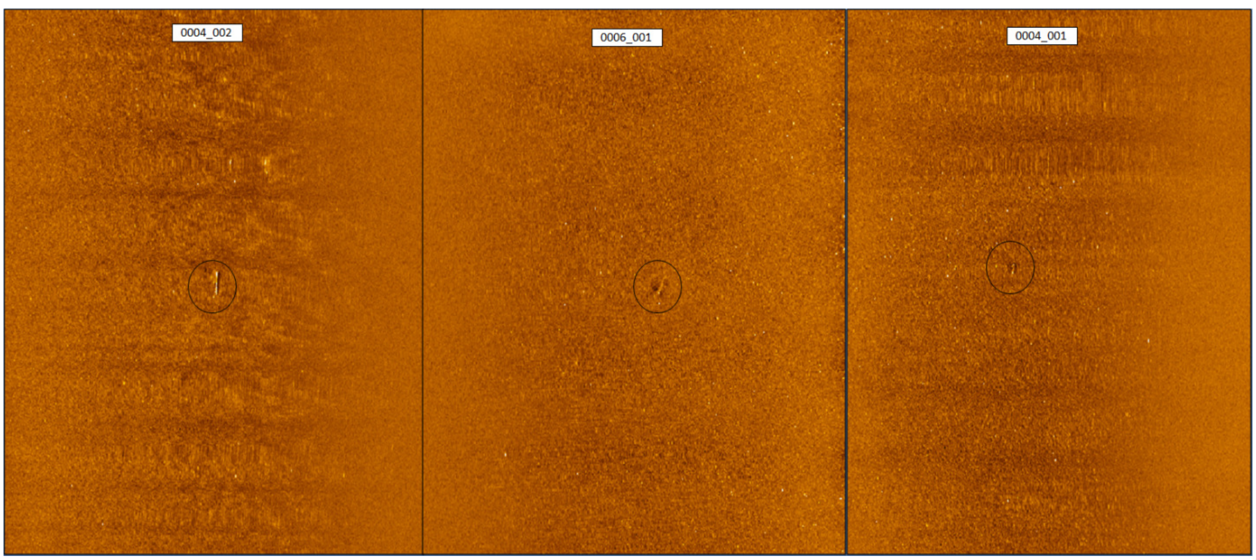



Figure 49 Linear objects in side scan data

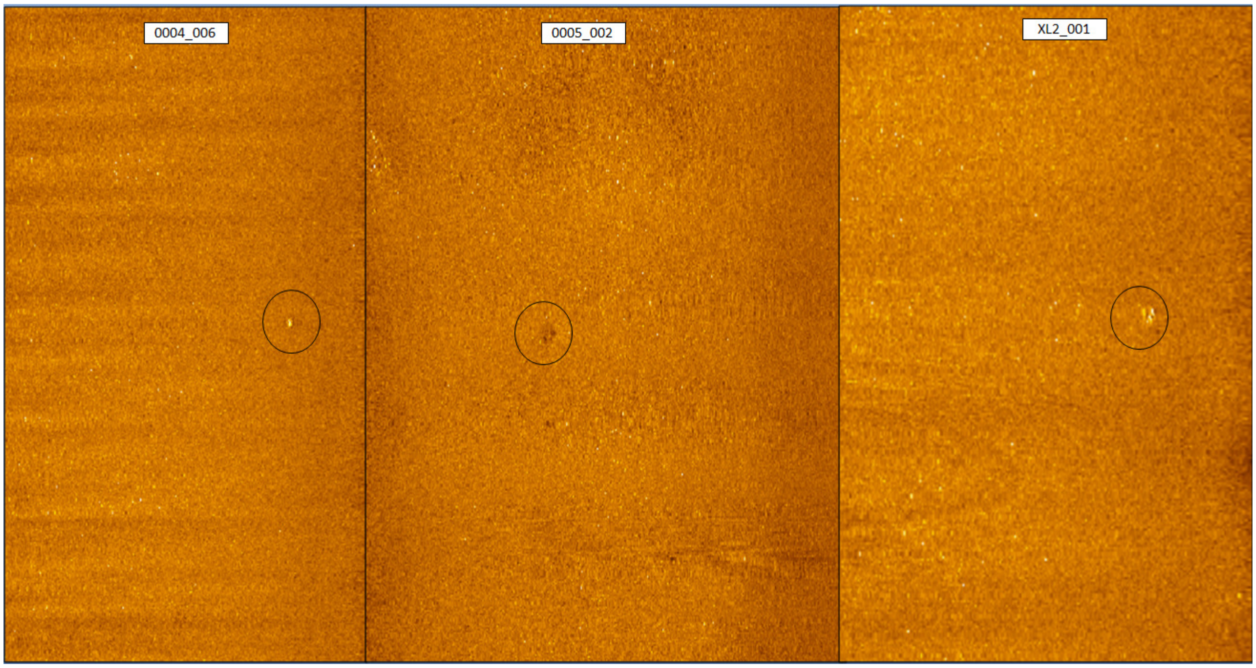



Figure 50 Unknown objects in side scan data (1of2)

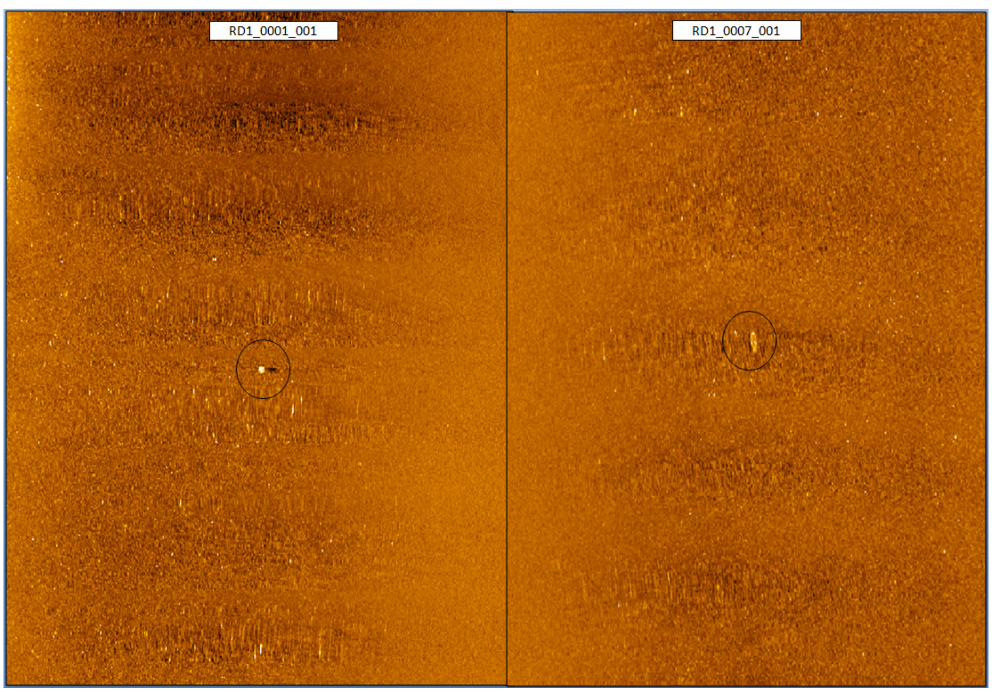



Figure 51 Unknown objects in side scan data (2of2)

## 6.5 Subsurface Geological Interpretation

Six (6) subsurface sediment facies were identified in the CHIRP sub-bottom data. These are located across sub-bottom profiles allowing areas of subsurface facies to be determined. The extents of these facies are shown below in Figure 52.

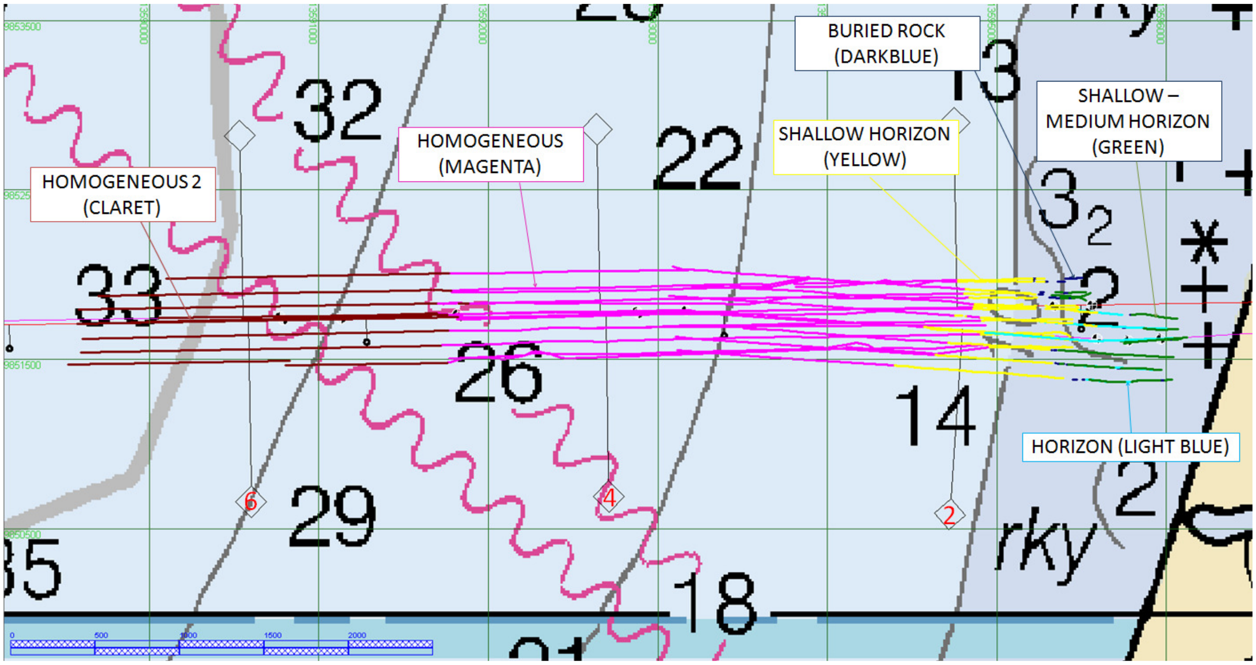



Figure 52: Subsurface Facies Identified Across the Survey Area

No core sample information was obtained or could be found within the survey area. Therefore, no attempt has been made to classify the sub-surface soil types. The surface sediment type is identified for each unit which can be assumed to be the sediment type from the surface to the first horizon.

Horizons identified were able to be grouped into three types based on the depth below the surface and the area located. The first horizon was located across lines in the nearshore area where the sea floor surface is between 5 and 18m. The average depth below the sea floor of this horizon is 3m. Penetration is observed below this horizon suggesting this is not a transition to hard material but a mud, silt or sand layer (based on the standard penetration of the Chirp sub-bottom system used). The location of these horizons, referred to as shallow-water medium horizon is shown below Figure 53 and an example of the horizon is below in Figure 54. At the surface above this horizon is loose sand with rock outcroppings adjacent to the horizon.

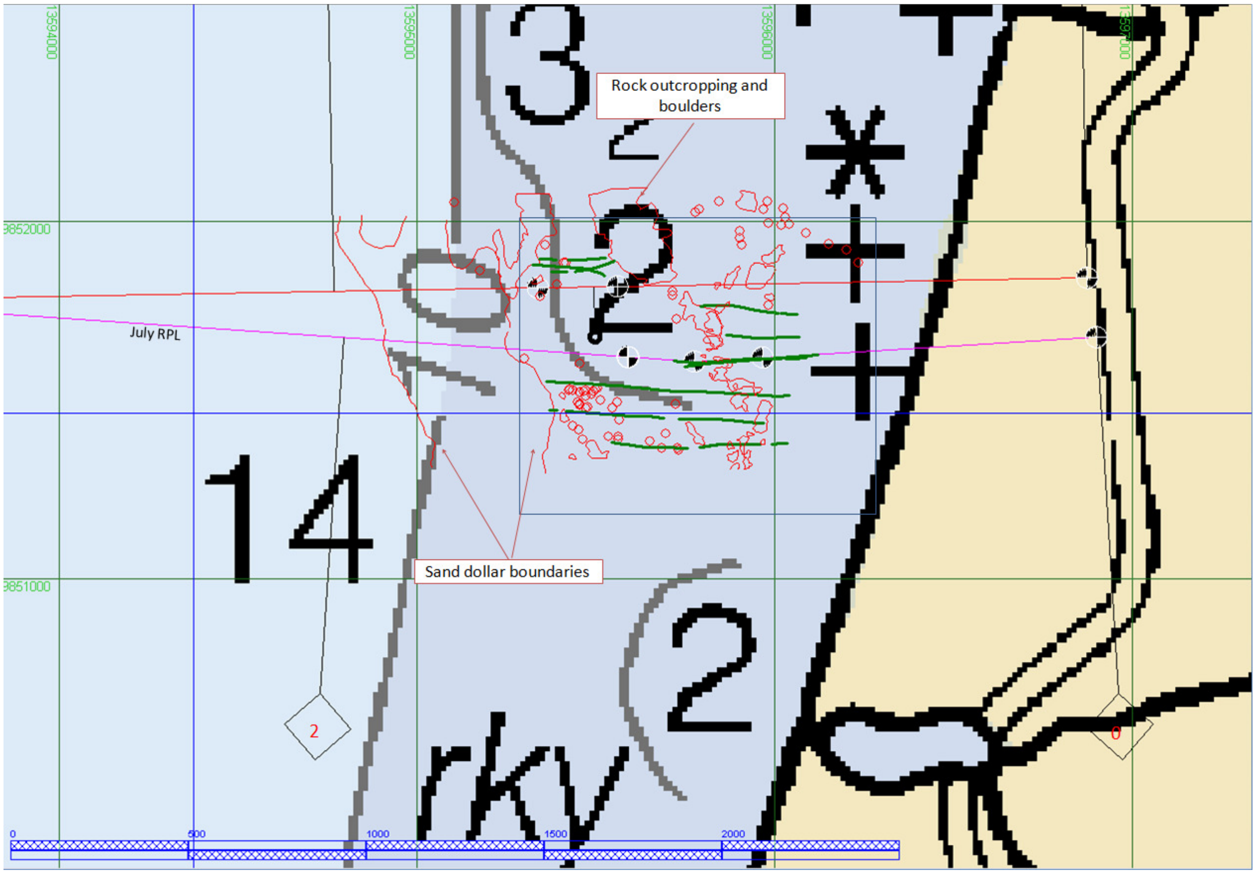



Figure 53 Location Shallow-water medium horizon

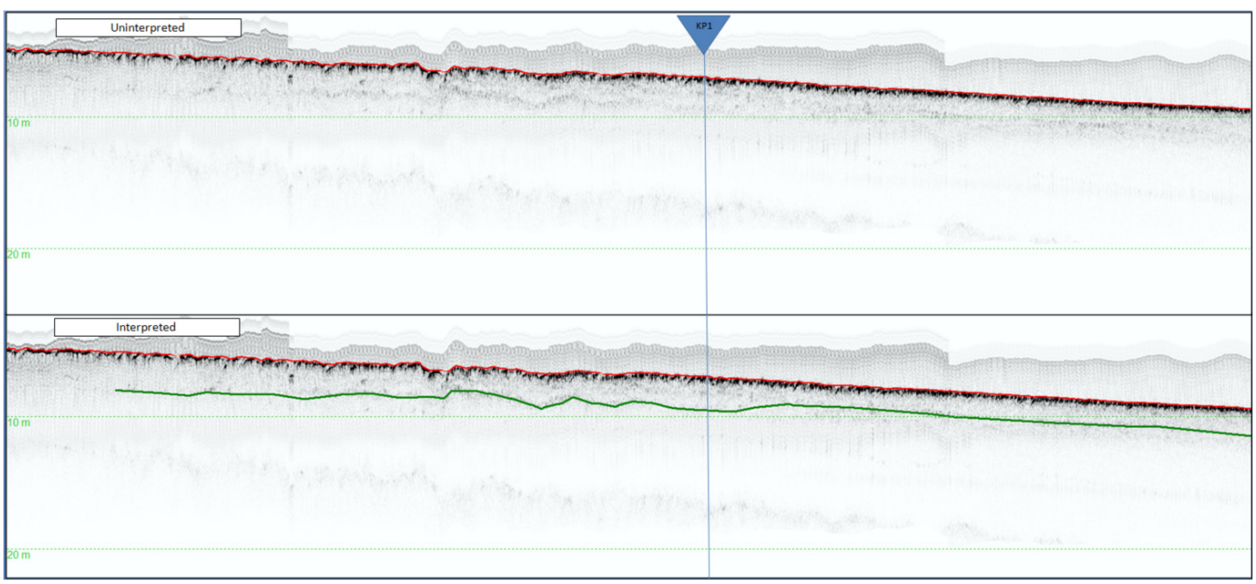



Figure 54 Shallow water medium horizon

In certain areas, below this initial horizon a further horizon was identified. The horizon is on average 10m below the sea floor. The horizon is faint suggesting that there is not a strong amplitude change from the sediment above to below the horizon. The horizon is generally flat compared to the sloping sea floor. The location of this horizon, referred to as simply Horizon is shown below Figure 55 and an example of the horizon in the sub-bottom data is in Figure 56. At the surface above this horizon is loose sand with rock outcroppings adjacent to the horizon.

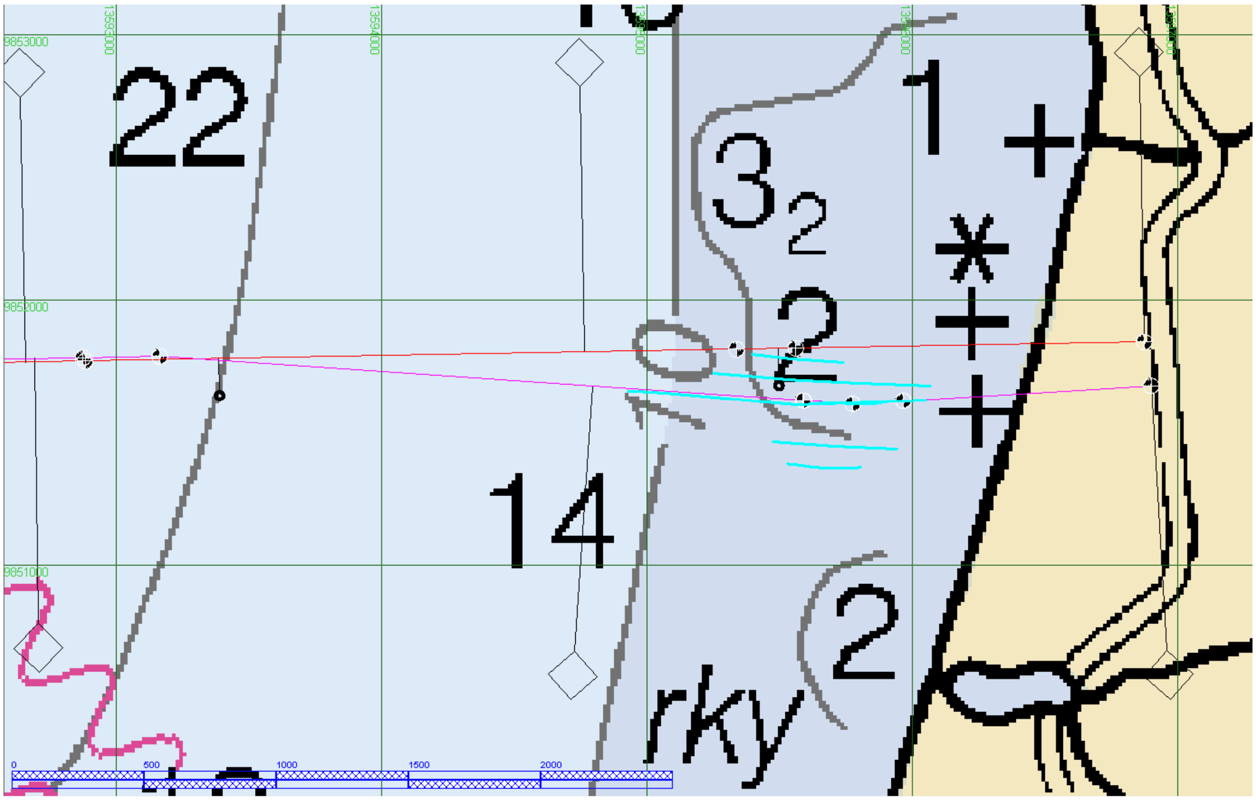



Figure 55 Location of the identified Horizon layer

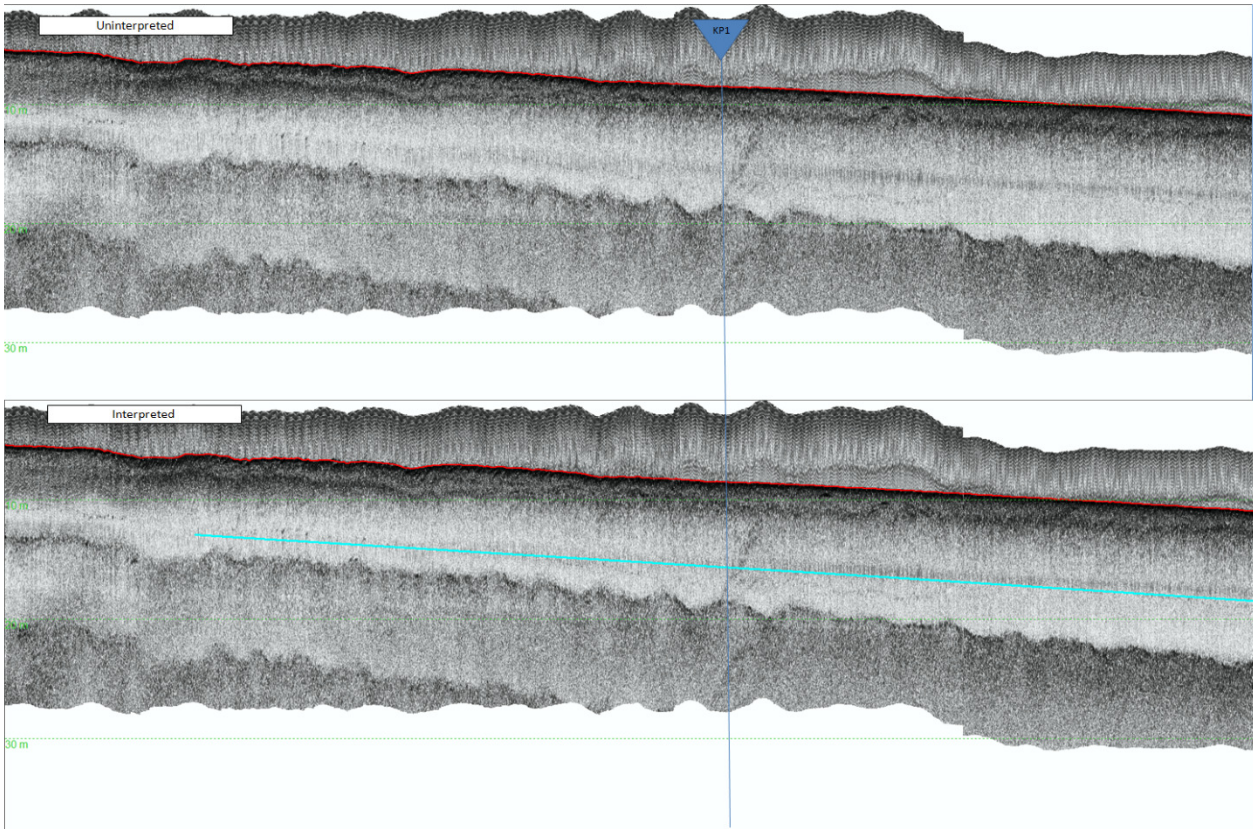



Figure 56 Horizon layer in the sub-bottom data

Further offshore from these horizons a third horizon was identified.  The horizon was consistently in water depths of greater than 11m down to 27m with a depth below the sea floor of never more than 2m.  This horizon is generally uneven suggesting a mixing of sediment and erosion as well as deposition activity.  The horizon is observed between and adjacent to the rock outcropping features but also related strongly to the area of sand dollars. The location of this horizon referred to as shallow horizon is below in Figure 57 with an example of the horizon in the sub-bottom profile in Figure 58.

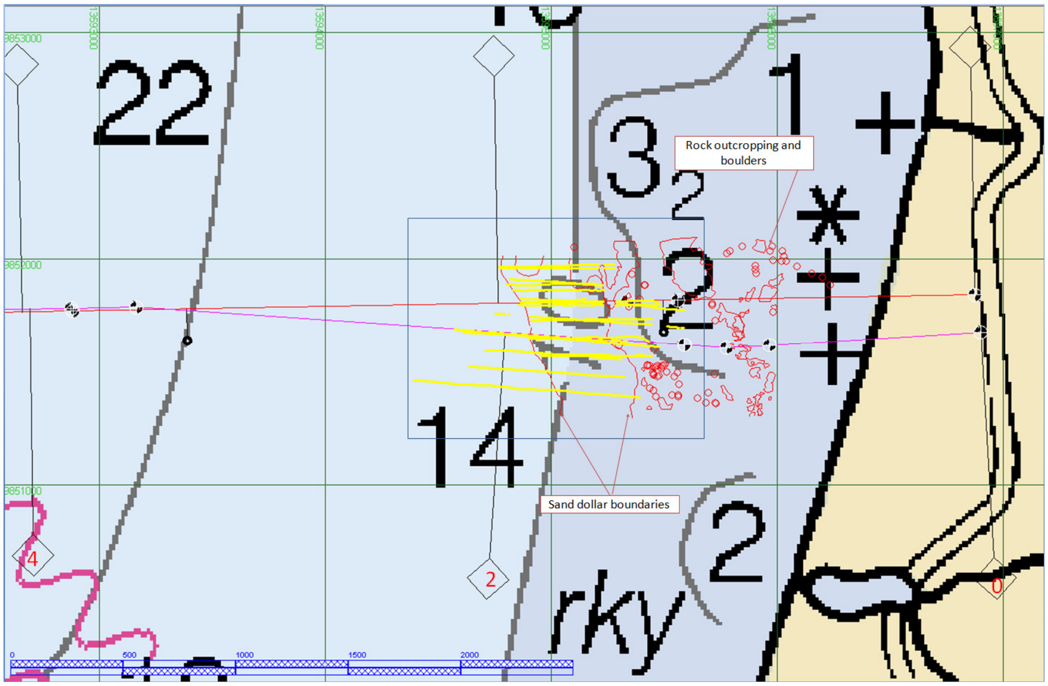



Figure 57 Location of Shallow horizon

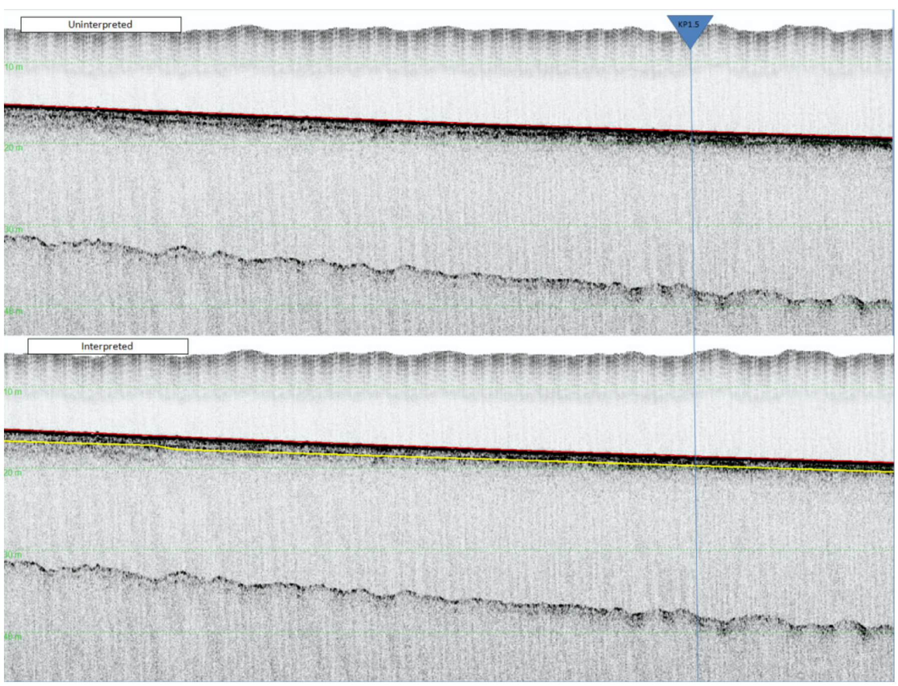



Figure 58 Shallow horizon layer in the sub-bottom data

Adjacent to areas where at the surface are rock outcroppings, buried rock formations were located. These are found in water depths of between 5 and 18m and buried between 2 and 10m below the sea floor.

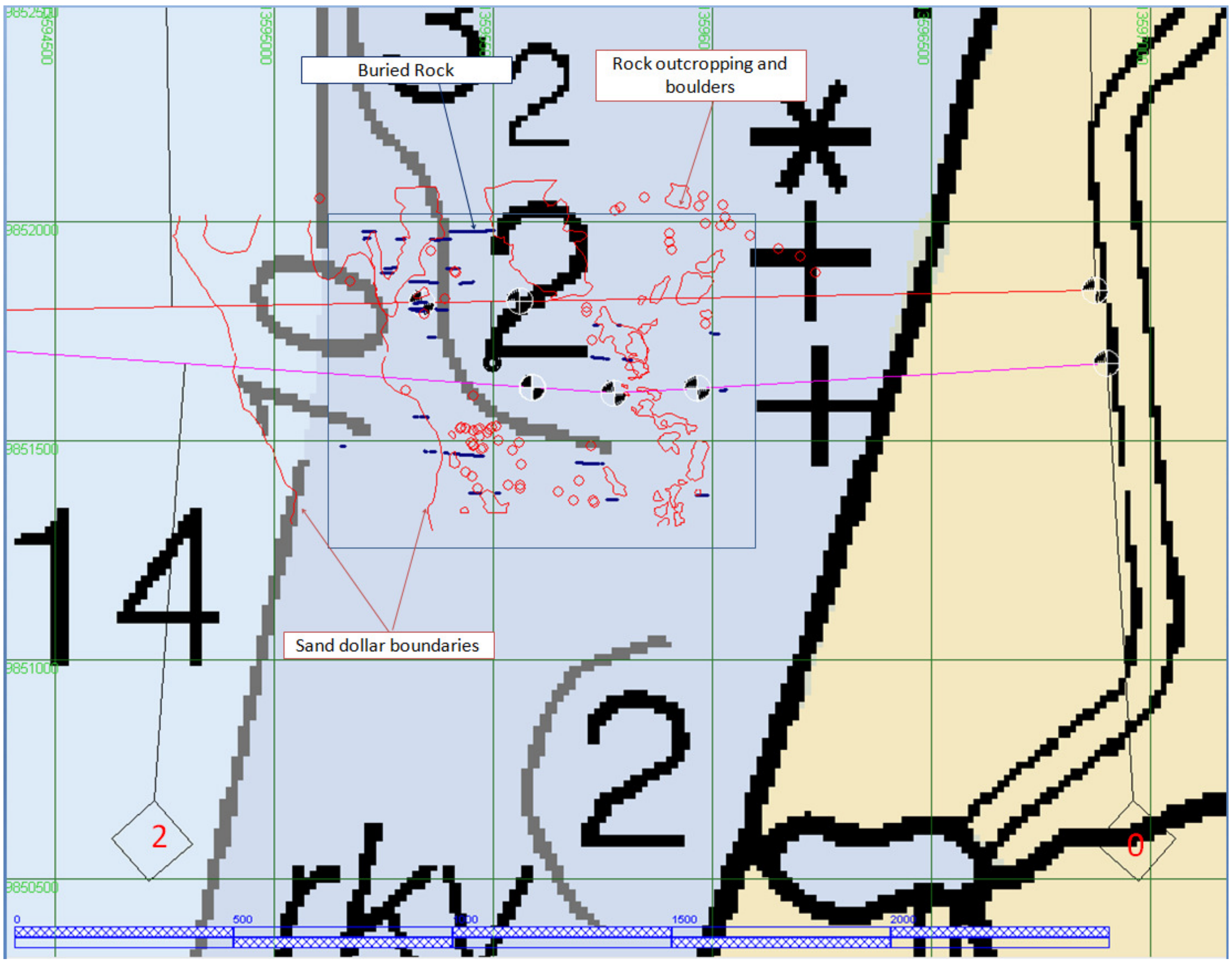



**Figure 59 Location of buried rock indentified in the sub-bottom profiler data**

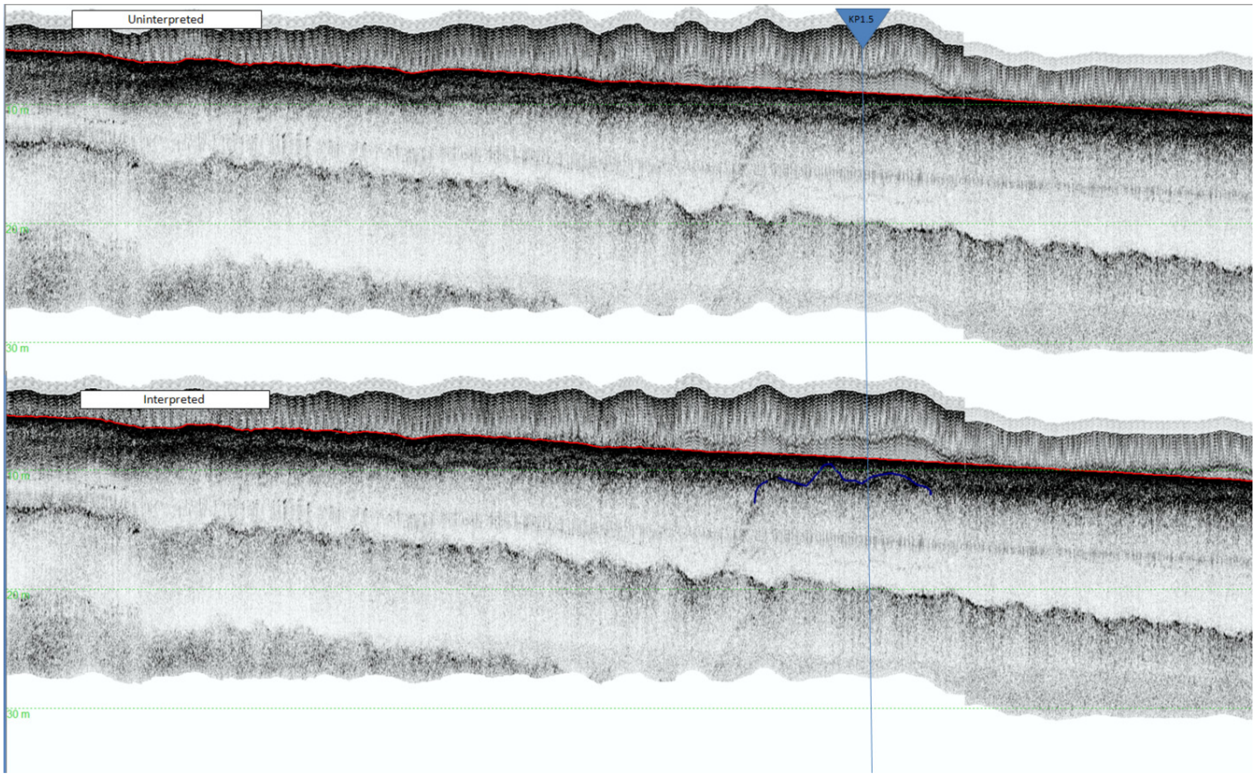



**Figure 60 Buried rock example in the sub-bottom data**

Two homogeneous sediment facies were identified further offshore from the horizons detailed above. The first was a homogenous unit with higher amplitude return near the surface. There were no horizons below this layer, but the amplitude of the return does become smaller to nonexistent below the surface. At the surface above this facies is loose sand. The eastern extents of this homogenous unit correlate with the border of the sand dollar area at the surface. The western extents of this facies correlates with the surface sediment change observed in the side scan sonar data and described above. This unit is considered to be made up of the same material as the surface; loose sand. This homogenous unit referred to as Homogeneous, is shown below in Figure 61 (extents of unit) and Figure 62 (example in the sub-bottom data).

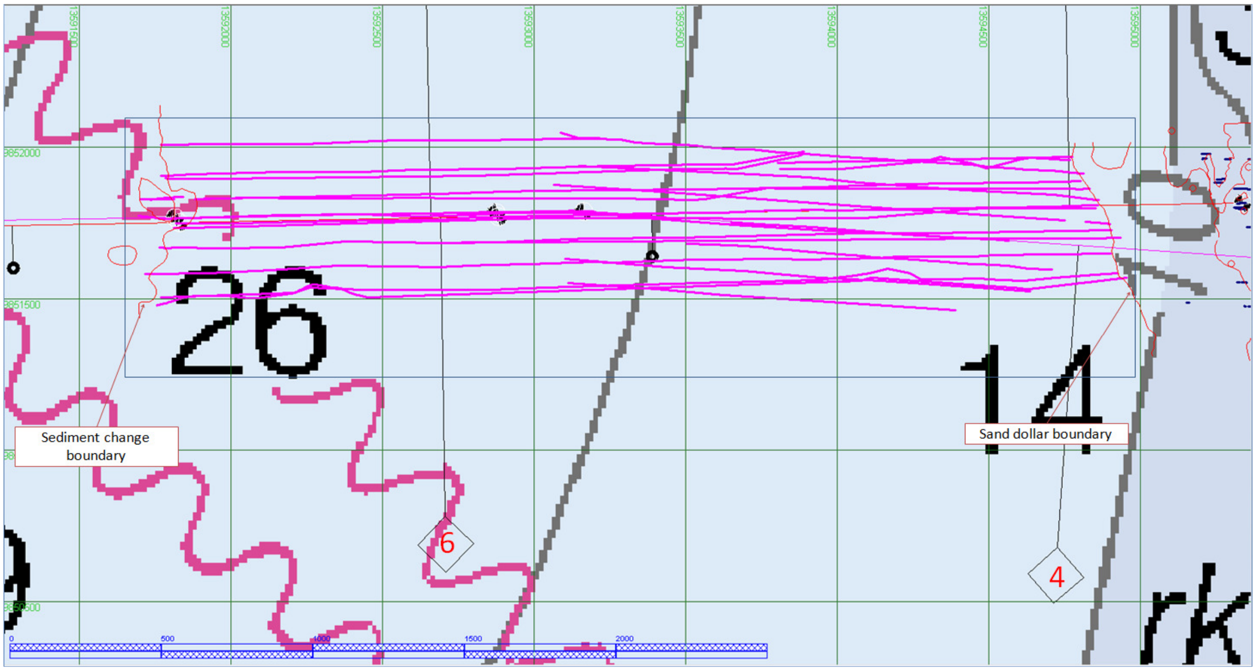



Figure 61 Location of homogeneous unit

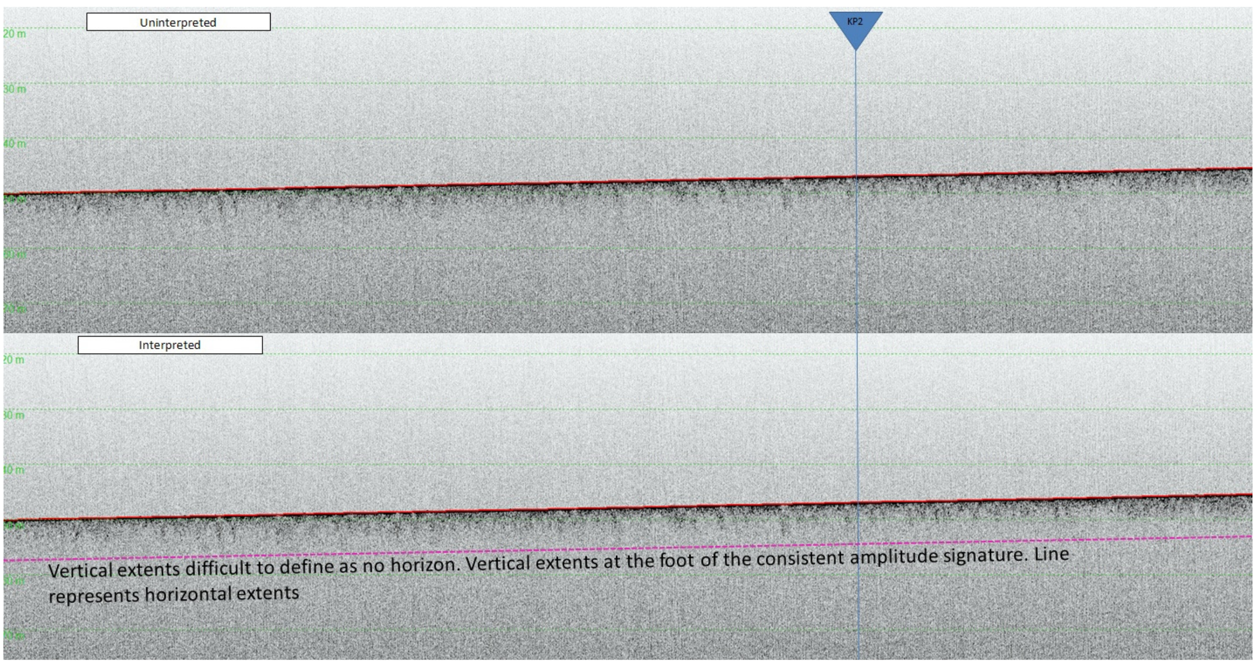



Figure 62 Homogeneous unit example in the sub-bottom data

To the west of the sediment change boundary a different subsurface homogeneous unit is present. This is referred to as Homogeneous2. There is little change in amplitude return from the surface down through the subsurface data. There is no discernible horizon or vertical extent to this unit as there is no change in amplitude through the profile. The surface consists of very loose sand.

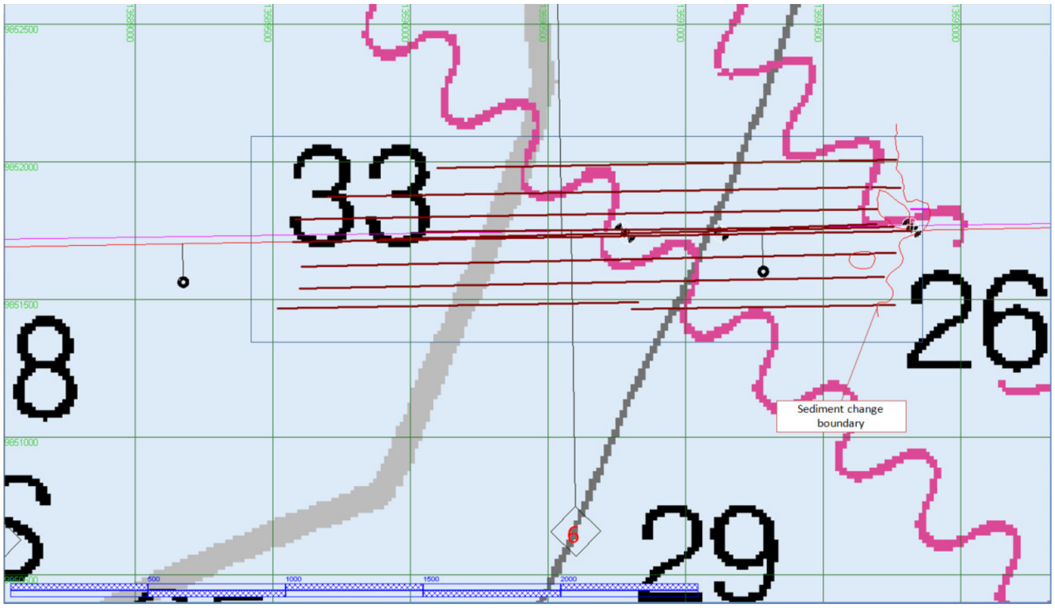



Figure 63 Location of Homogenous 2 unit

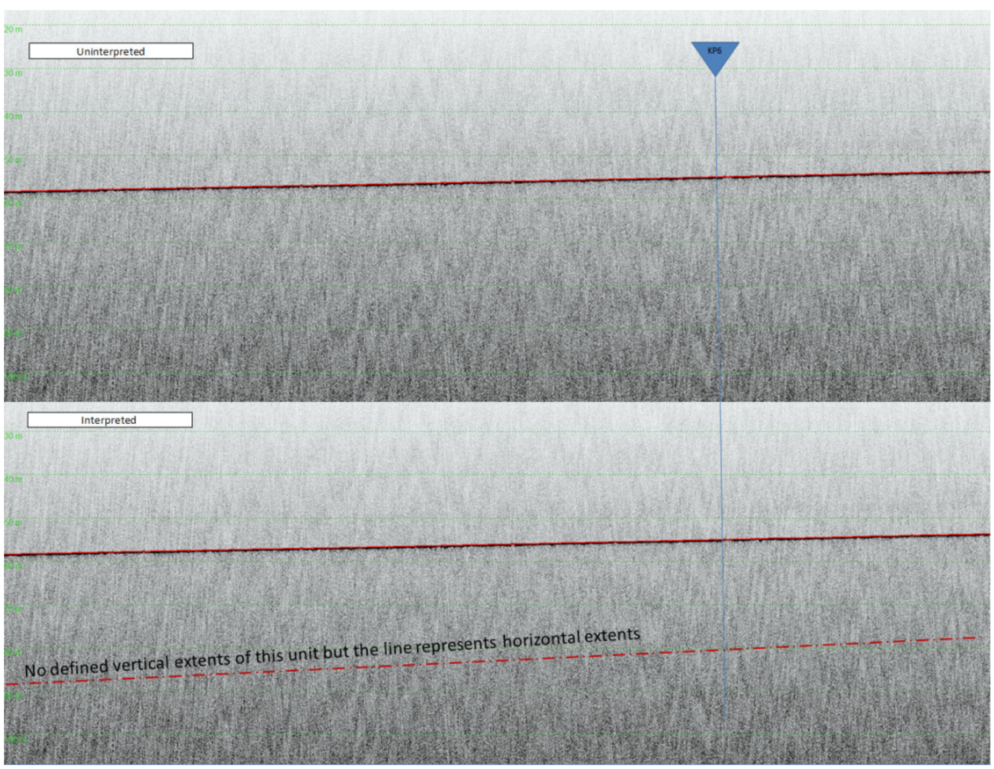



Figure 64 Homogeneous2 unit example in the sub-bottom data

## 6.6 Isolated Subsurface Features

Two (2) isolated subsurface features were identified across the survey area. The locations of these features are shown below in Figure 65.

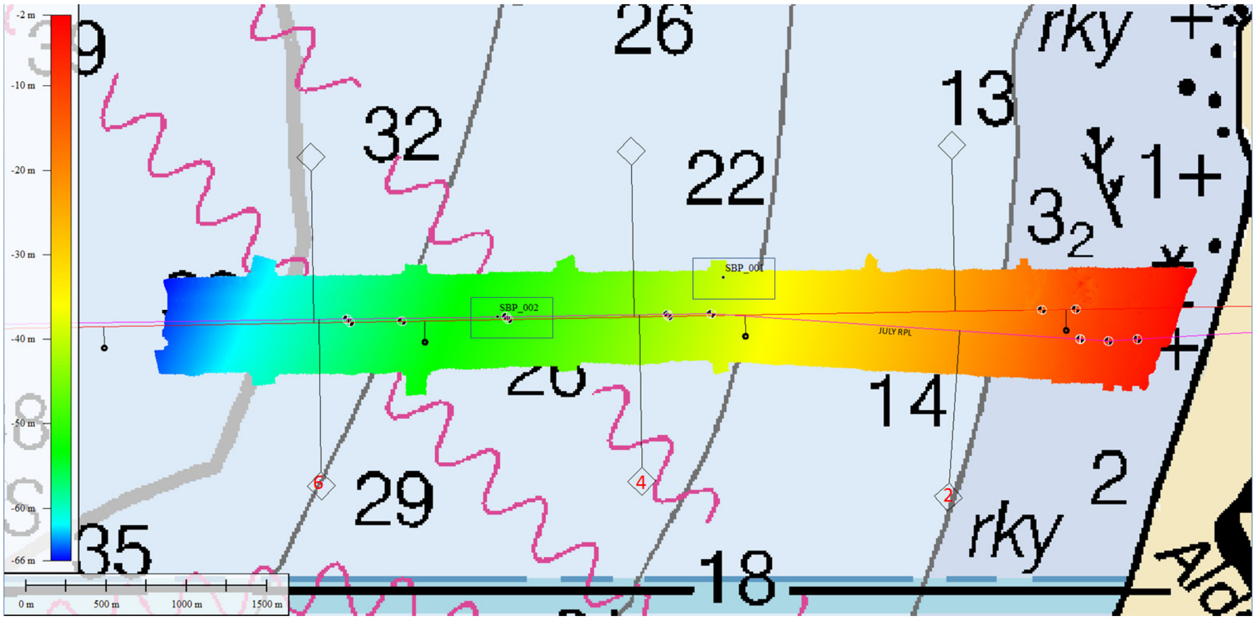



Figure 65: Distribution of Isolated Subsurface Features within the Survey Area

Table 5 lists the isolated features with depths below the seabed and images of the features in the sub-bottom data are in Figure 66and Figure 67.

Table 5: Subsurface Isolated Features

| Object ID | Coordinates (WGS84) | | Coordinates (Easting, Northing) | | KP | DCC | Depth Below Seabed (meters) |
|---|---|---|---|---|---|---|---|
| SBP-001 | 39;01.05055 N | 123;43.78732 W | 13593245.44 | 9852026.95 | 3.46 | 244 | 0.1 |
| SBP-002 | 39;00.91661 N | 123;44.76191 W | 13591762.63 | 9851765.72 | 4.82 | 14 | 0.3 |

Both features produced clear parabolas in the sub-bottom data and are buried to a maximum 30cms.

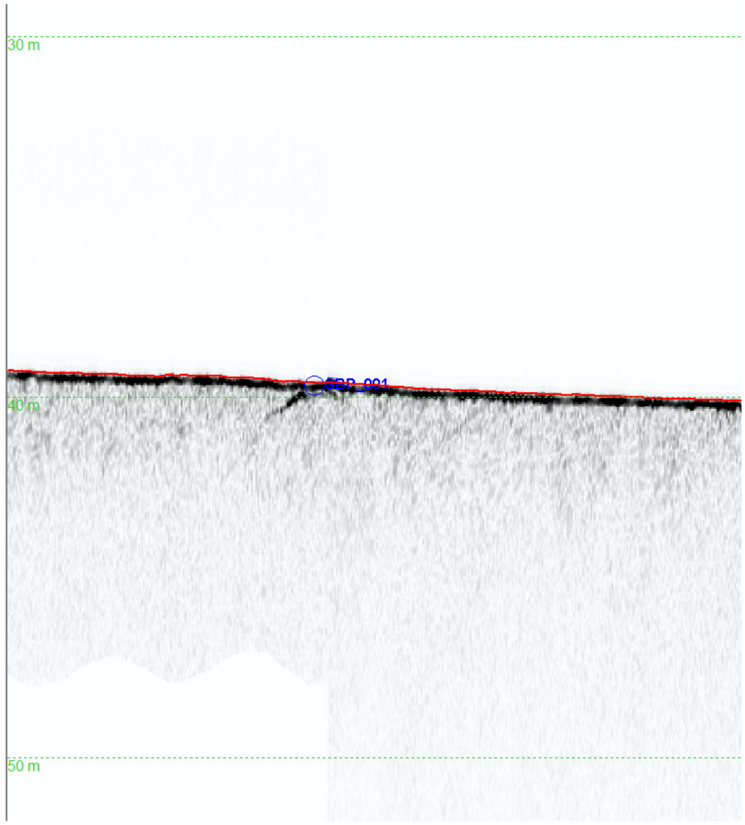



**Figure 66 Isolated subsurface feature - SBP-001**

SBP-002 is considered an isolated object, however, it is located within 10m of the crossing cable alignment as indicated by the magnetometer data. This is described below in the magnetometer section. This subsurface target could represent the depth of the cable crossing below the surface.

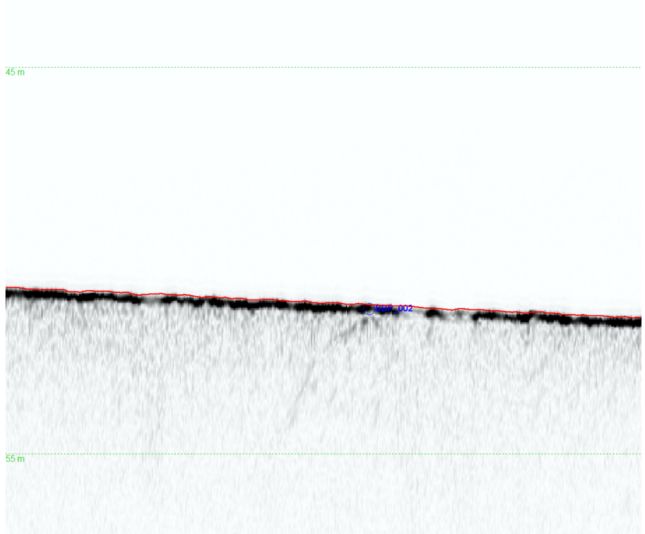



Figure 67 Isolated subsurface feature - SBP-002

## 6.7 Cable Crossings and Ferrous objects

Thirty-six (36) magnetic anomaly contacts were identified inj the survey. These are listed below in Table 6.

**Table 6 Magnetometer contact listing**

| | | | | | | Start and end of magnetic anomoly picked | | |
|---|---|---|---|---|---|---|---|---|
| Unique ID | Easting | Northing | Latitude | Longitude | Gamma Reading | Duration - start of pick to end of pick (meters) | Gamma change (Peak to Peak) | Description |
| Mag-1 | 13590661.28 | 9851748.39 | 39° 00.9077' N | 123° 45.4798' W | 48628.10 | 23.17 | 31.59 | Charted Cable crossing |
| Mag-2 | 13592896.44 | 9851785.46 | 39° 00.9259' N | 123° 44.0106' W | 48637.10 | 105.15 | 30.54 | Charted Cable crossing |
| Mag-3 | 13590791.51 | 9851758.55 | 39° 00.9130' N | 123° 45.3944' W | 48611.00 | 48.18 | 20.84 | Charted Cable crossing |
| Mag-4 | 13591837.49 | 9851769.08 | 39° 00.9182' N | 123° 44.7066' W | 48618.50 | 27.16 | 4.45 | Charted Cable crossing |
| Mag-5 | 13592734.79 | 9852009.18 | 39° 01.0421' N | 123° 44.1285' W | 48593.20 | 65.86 | 8.49 | Charted Cable crossing |
| Mag-6 | 13595154.49 | 9851810.95 | 39° 00.9403' N | 123° 42.5384' W | 48656.60 | 70.62 | 40.15 | Charted Cable crossing |
| Mag-8 | 13595768.06 | 9851773.79 | 39° 00.9212' N | 123° 42.1352' W | 48678.20 | 70.13 | 49.36 | Unknown feautre |
| Mag-9 | 13595270.41 | 9851642.86 | 39° 00.8531' N | 123° 42.4510' W | 48657.20 | 76.15 | 21.57 | Uncharted utility crossing |
| Mag-10 | 13595419.23 | 9851394.25 | 39° 00.7253' N | 123° 42.3523' W | 48628.80 | 70.22 | 14.11 | Uncharted utility crossing |
| Mag-11 | 13593910.21 | 9851494.30 | 39° 00.7774' N | 123° 43.3447' W | 48587.70 | 37.27 | 3.59 | Unknown feautre |
| Mag-12 | 13592730.52 | 9852020.82 | 39° 01.0473' N | 123° 44.1316' W | 48591.4 | 199.06 | 11.15 | Abandoned cable crossing |
| Mag-13 | 13591588.50 | 9852023.14 | 39° 01.0483' N | 123° 44.8808' W | 48587.50 | 29.86 | 1.78 | Charted Cable crossing |
| Mag-14 | 13590536.48 | 9851986.43 | 39° 01.0297' N | 123° 45.5733' W | 48584.40 | 21.02 | 5.83 | Charted Cable crossing |
| Mag-15 | 13590871.65 | 9851673.80 | 39° 00.8697' N | 123° 45.3414' W | 48588.40 | 34.34 | 5.76 | Charted Cable crossing |
| Mag-16 | 13592953.09 | 9851708.43 | 39° 00.8874' N | 123° 43.9736' W | 48583.90 | 225.80 | 11.28 | Abandoned cable crossing |
| Mag-17 | 13590599.98 | 9851914.80 | 39° 00.9924' N | 123° 45.5318' W | 48594.70 | 24.56 | 16.82 | Charted Cable crossing |
| Mag-18 | 13591650.75 | 9851929.05 | 39° 01.0000' N | 123° 44.8410' W | 48582.70 | 33.67 | 3.52 | Charted Cable crossing |
| Mag-19 | 13592755.84 | 9851938.53 | 39° 01.0051' N | 123° 44.1153' W | 48578.10 | 110.43 | 12.11 | Abandoned cable crossing |
| Mag-21 | 13590965.31 | 9851599.35 | 39° 00.8314' N | 123° 45.2800' W | 48586.40 | 23.97 | 6.90 | Charted Cable crossing |
| Mag-22 | 13591684.73 | 9851608.98 | 39° 00.8361' N | 123° 44.8074' W | 48584.70 | 26.03 | 2.81 | Unknown feautre |
| Mag-23 | 13591955.22 | 9851605.15 | 39° 00.8346' N | 123° 44.6290' W | 48579.30 | 28.77 | 2.95 | Charted Cable crossing |
| Mag-24 | 13592533.44 | 9851619.90 | 39° 00.8420' N | 123° 44.2493' W | 48587.20 | 42.23 | 12.25 | Unknown feautre |
| Mag-25 | 13592963.71 | 9851630.72 | 39° 00.8475' N | 123° 43.9663' W | 48585.10 | 92.01 | 15.26 | Abandoned cable crossing |
| Mag-26 | 13592827.36 | 9851858.85 | 39° 00.9642' N | 123° 44.0685' W | 48582.60 | 171.18 | 12.51 | Abandoned cable crossing |
| Mag-27 | 13591748.38 | 9851844.22 | 39° 00.9569' N | 123° 44.7786' W | 48591.10 | 29.61 | 3.30 | Charted Cable crossing |
| Mag-28 | 13590698.65 | 9851826.19 | 39° 00.9476' N | 123° 45.4674' W | 48591.20 | 28.74 | 1.91 | Charted Cable crossing |
| Mag-29 | 13590995.03 | 9851516.00 | 39° 00.7890' N | 123° 45.2603' W | 48615.20 | 57.04 | 2.55 | Charted Cable crossing |
| Mag-30 | 13592017.60 | 9851530.58 | 39° 00.7962' N | 123° 44.5880' W | 48606.40 | 50.35 | 4.62 | Charted Cable crossing |
| Mag-31 | 13593015.60 | 9851548.54 | 39° 00.8055' N | 123° 43.9322' W | 48622.00 | 105.11 | 18.54 | Charted Cable crossing |
| Mag-32 | 13595098.28 | 9851893.91 | 39° 00.9828' N | 123° 42.5761' W | 48671.80 | 74.20 | 28.74 | Uncharted utility crossing |
| Mag-33 | 13592869.40 | 9851792.92 | 39° 00.9298' N | 123° 44.0412' W | 48609.70 | 68.95 | 30.72 | Abandoned cable crossing |
| Mag-34 | 13591812.51 | 9851775.16 | 39° 00.9214' N | 123° 44.7346' W | 48612.50 | 32.89 | 4.90 | Charted Cable crossing |
| Mag-35 | 13590768.25 | 9851757.14 | 39° 00.9124' N | 123° 45.4206' W | 48616.80 | 35.59 | 3.25 | Charted Cable crossing |
| Mag-36 | 13595201.65 | 9851728.29 | 39° 00.8975' N | 123° 42.5073' W | 48606.30 | 156.53 | 26.14 | Uncharted utility crossing |

The magnetometer data successfully tracked two charted cables and then appeared to identify two non charted cables that cross the RPL. At least five magnetic anomaly targets were indentified along each assumed alignment.

Two charted cables cross the RPL at KP 5.9 and 5.1. The alignment of the cables as according to the magnetometer data correlates with the NOAA charted (POINT ARENA TO TRINIDAD HEAD (1:200000 scale) position of the cables. The map in Figure 68 shows the magnetic anomaly targets with the chart in the background.

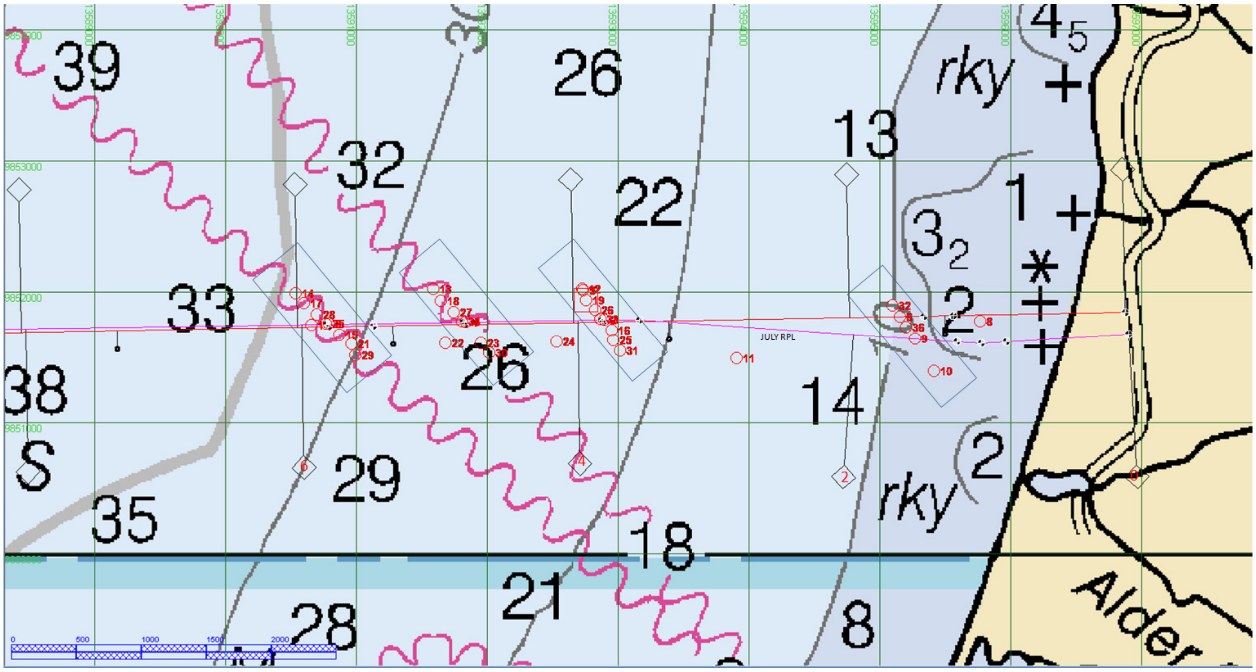



Figure 68 Map showing magnetometer anomaly targets with NOAA chart in background

Two other uncharted cable or pipe crossings can be assumed from the data. Seven (7) targets create an alignment across the RPL at KP 3.8 and four (4) targets create an alignment across the RPL at KP1.4. In Fugro document P03437 - HKA - Inshore Survey in CA - 14 May 2018.pdf a third existing cable is noted in an image of the Manchester survey area (see below Figure 69). This third cable is not on any NOAA charts, however, this is referred to as out-of-service cable TPC-4 and is in line with the cable crossing identified in the magnetometer data at KP3.8.

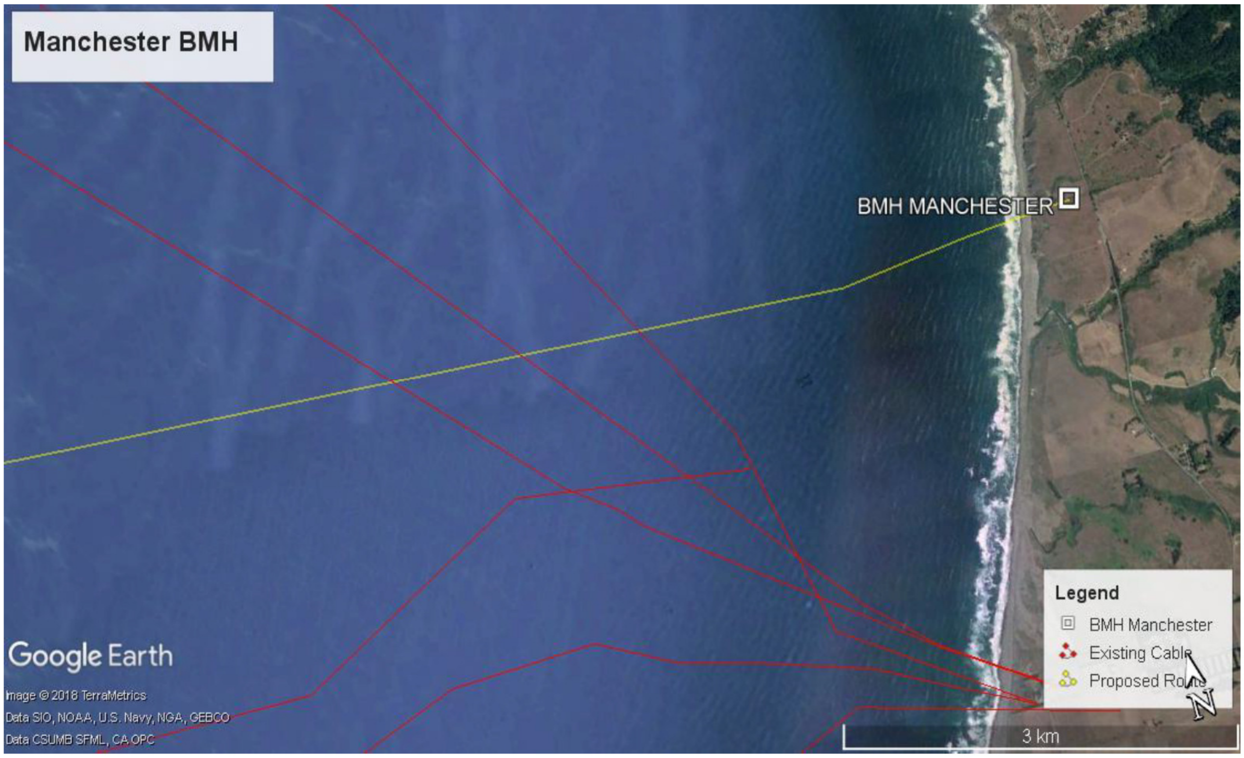



**Figure 69 Image from document P03437 - HKA - Inshore Survey in CA - 14 May 2018.pdf showing a third existing cable across the Manchester Landing RPL**

Four (4) other magnetic anomalies were noted in the area. None of these are located within 10m of a surface feature detected. However, within 10m of the alignment of charted cable crossing at KP3.8 created using the magnetometer data, is the contact SBP-002. This sub surface contact could represent the depth of the cable at the crossing point.

# 7 CONCLUSIONS

The Manchester survey comprised of multibeam, sidescan sonar, magnetometer and sub-bottom profiler along the proposed cable route. Sediment samples were also collected along the cable route to establish sediment types for correlation with the bathymetric and geophysical data.

Generally, the seabed gradient in the survey area is gentle with slope angles across the area less than 1°. Depths in the survey area range from approximately 1.6m LAT to 66.2m LAT.

The seabed sediments along the proposed route were found to be composed of sand with rock outcroppings the only other substrate type in the area.

Eight (8) objects with a strong return were found in the survey area using sidescan sonar. These were categorized as unknown objects or linear unknown objects.

Two (2) isolated subsurface features, defined by parabolas in the CHIRP sub-bottom profiler data, were identified across the survey area. One of these targets (SBP-002 in Table 5) is possibly a point of the charted cable crossing the RPL at KP3.8.

Six (6) subsurface sediment facies were identified in the CHIRP sub-bottom data. Buried rock was identified along with three horizon layers separating sediments units. Offshore from KP2 only homogenous units were identified.